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TRIAL TRIP OF THE NEW PROTECTED CRUISER COLORADO.

A new speed record of the United States Navy for vessels carrying side armor, was recently made by the *Colorado* when she covered the Cape Ann course of 88 miles at an average speed of 22.24 knots. Previous to this the record has been held by the *Brooklyn,* which made 21.91 knots. The *Colorado* is one of six similar vessels now nearing completion, the others being the *Maryland, Pennsylvania, South Dakota, California,* and *West Virginia.* All these ships are contracted for 22 knots, and the *West Virginia* on November 2 covered the Cape Ann course at 22.14 knots. The principal dimensions of hull and machinery of this class of vessels have been previously given in MARINE ENGINEERING,* and suffice it to add that these ships may be considered the most efficient and powerful armored cruisers afloat, both in point of armor and armament.

There is a complete water line belt or armor 7 feet 6 inches deep, which has a maximum thickness of 6 inches, diminishing to 3 1-2 inches at the ends. Above this is side armor 5 inches thick carried up to the main deck, with 4-inch thwartship armor at the ends. The protective deck varies in thickness from 1 1-2 inches on flats to 4 inches on the slopes. The battery consists of four 8-inch rapid-fire guns, mounted in two 6-inch barbettes, one forward and one aft, and fourteen 6-inch rapid-fire guns placed on the gun deck behind the side armor and separated from each other by 2 1-2-inch splinter bulkheads. The ammunition hoists are capable of conveniently supplying the guns with ample amount of powder and shell, and all hoists are driven by electricity.

The addition of these six fighting ships to our navy will be a very material one, as they are not only capable of steaming at high speed but of taking their position in battle line.

UNITED STATES PROTECTED CRUISER COLORADO, ENTERING DRY-DOCK, PREVIOUS TO TRIAL TRIP ON WHICH SHE MADE 22.24 KNOTS.
[Photograph Copyrighted, 1904, by Enrique Muller.]

*See MARINE ENGINEERING, page 317, (*California*); page 402 (*South Dakota*).

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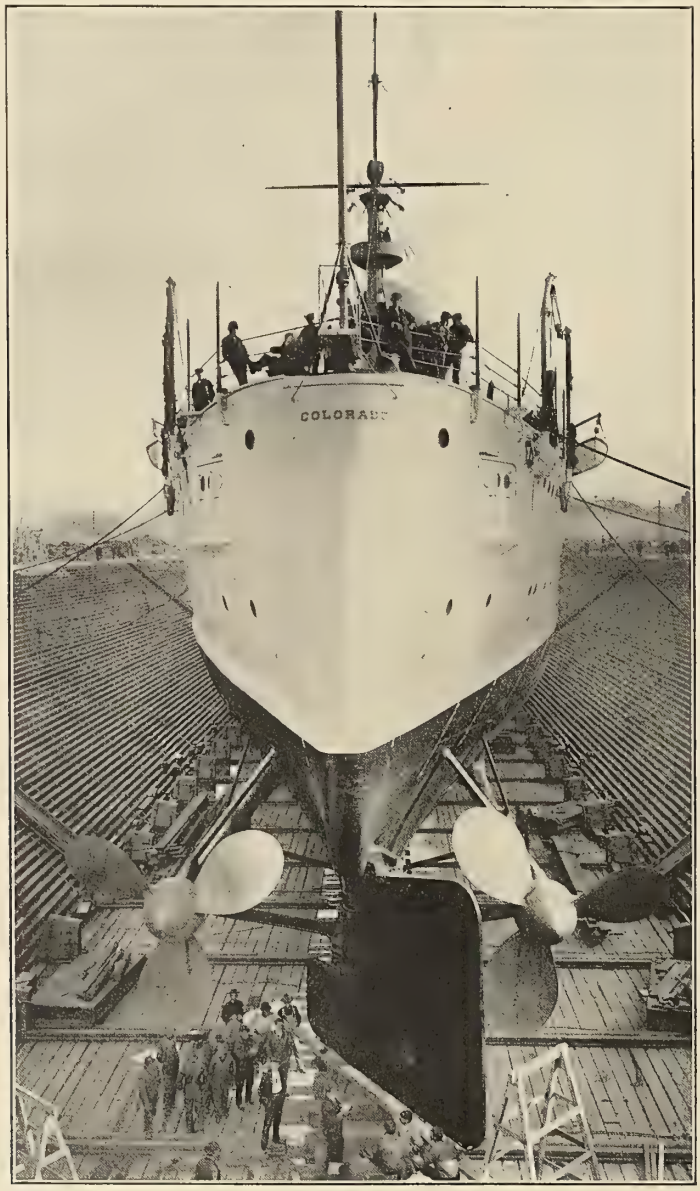
An Exciting Time Off Charleston in 1862.

BY F. C. RUSSELL.

Fire at sea is a fearful foe to combat, and when we add to this the possibilities of an explosion in a magazine stored with powder and shot, we have factors which are far reaching in their results, and may well be dreaded; such were the conditions on the gun boat *Huron,* December 22, 1862. The good effect of thorough discipline was very manifest at this time. The writer was then an engineer on the *Huron,* and for several weeks we had been having "fire drill," "calling to quarters," and giving the alarm, at most unexpected times, but the drill was tame in comparison to the real experience of fire. On this particular day we received signals to run down to the flag ship, the *Powhatan,* off Charleston bar. Our port boiler had been leaking for several days, requiring the constant assistance of the donkey pump. Between ten and eleven in the forenoon one of the tubes in the port boiler burst, throwing some fire into the fire room. The cry of "Fire!" was heard, all hands were called to quarters, and the fire alarm sounded. Nothing of the ship was then visible from the smoke pipe to the stern, because of smoke and steam.

Our captain, Lieutenant-Commander George A. Stevens, was immediately on the bridge, and the first order given inspired confidence. Never shall we forget the word which came thundering from that bridge, distinctly audible above the hissing of steam, and crackling of burning wood: "Silence! fore and aft!" and then we knew there was a cool head to direct affairs, and discipline came to the front. The engines were ordered stopped immediately. There was some duty for every one except the paymaster. In far less time than it takes to tell this story, a line of hose was run along the deck,



STERN VIEW OF THE CRUISER COLORADO IN NAVY YARD DRY-DOCK.

[Photograph Copyrighted, 1904, by Enrique Miller.]

and a stream of water directed down the fire room hatch way. Fire was hauled from the remaining furnace in the boiler, and one of the engineers, with a bunch of cotton waste over his face, crawled over one of the steam pipes and shut off the connection between the two boilers.

On deck matters were also progressing rapidly. Signals of distress were hoisted, all our boats were swung over the rail ready for lowering, a bag of hard tack and keg of water in each boat. All our guns were discharged, so in case we left the ship we should not be in danger from our own guns, and the loose shot and shell were placed ready to throw overboard. The only person who seemed at all over excited (I will not say afraid), was the paymaster, for the very apparent reason there was nothing for him to do. He rushed on deck and called to the master's mate in charge of the 24 pounders on our quarter, "Fire those howitzers!" The mate told him to keep quiet, he would fire those guns when he received orders. The impression received at that time has never left me, that the best nerve tonic in a time of danger is to be in the line of duty with a definite thing to do.

My position in connection with hose and pumps at fire quarters called me on deck at such times, and I was enabled to observe much more than I otherwise should had I been on watch below. We found the real damage to the ship was slight, a little wood work around one of the coal bunkers was all that was burned, and the whole affair was over in about twenty minutes. Our chief engineer, in assisting below, stepped into the hot water in the fire room, burning his heel, and was obliged to sit with his foot on a pillow for a week or ten days after. One of our first-class firemen, who was in back of the engine, rushed out between the engine and boiler, scalding his neck and arms. He was promptly treated by our surgeon, who tore a bed quilt apart, using the cotton to make some kind of a plaster. This fireman received such a shock that we could not get him to again touch a shovel on either of the furnaces, so on his recovery we put him in charge of the engineer's stores.

In answer to our signal of distress boats from other vessels in the fleet began to put off for us, and the first boat to come within hailing distance was the second cutter from the United States steamer *Stettin*. The officer in charge of the boat called to us, "*Huron* a-hoy! What's the matter on board?" By this time, however, the fire was all out and the answer went back from an excited officer of the deck, "We are all right!" The cutter then went back to the *Stettin*, and all they could learn on that ship for a long time about the matter on the *Huron* was that she was "all right."

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 78 sail and steam vessels of 14,024 gross tons built in the United States and officially numbered during the month of October, 1904. The largest steel steam vessel included in these figures is the *Elizabeth*, of 1,197 gross tons, built at Wilmington, Del., and the largest wooden vessel is the schooner *Jane Palmer*, of 3,138 gross tons, built in Boston, Mass.

ELECTRIC HAULAGE IN GERMANY.

BY CLARENCE B. SCHULTZ, DR. ENG.

The transportation of large masses of bulky merchandise and raw materials has always been a problem of keen interest to the parties concerned. The well-known fact that there is no cheaper way than to ship by water keeps the question of improving the natural water ways and connecting the different rivers systems by artificial canals continually before the authorities of all thriving and well governed countries.

A good example of modern rapid transit by water and one representing probably the farthest developed state of art at the present time is the Teltow canal, near Berlin, Germany.

The moving facts for building the canal, the preparations leading up to the system of traction best adapted for the purpose, the description of the machinery finally adopted, and a financial review of the different electric haulage systems will be treated here more fully.

The capital of the German empire, besides being a railroad center of the first order, has a rapidly increasing traffic by water. Ten million gross tons is expected to be this year's figure for the cargo that arrived and left. Of this amount about two million tons pass in transit. Berlin's figures for the last two years are:

	1902	1903
Number of barges in transit,	6 442	6 562
" " " arrived,	54 476	66 218
" " " sailed	53,315	65.243
Gross tons of cargo in transit	1.293,206	1.396,724
" " " arrived	5,361,964	6,793.138
" " " shipped	591,864	731,561

Berlin's numerous water ways and harbors becoming more and more crowded, the barges passing the city in transit were subjected to much delay. In order to relieve Berlin it was decided that a canal should be built to circumvent the city, connecting the river travel with the Spree to the south. By this new water way the transit traffic was to be diverted from the city canals and at the same time numerous suburbs obtained the very desirable communication by water. The county of Teltow, surrounding Berlin, was authorized by the government to take up the necessary funds and to build the canal through its territory. The route of the Teltow canal, which is nearly completed and partially in use at the present time, can be seen on Fig. 1.

A few further data may be welcome for general information. The length of the Teltow canal is about 23 miles, the cross section averages about 800 square feet, having a depth of 8 1-4 feet at low water. The flow of the water is very slow, being less than 14 inches per second at high water.

In order to increase the efficiency of the canal it was decided to adopt some electrical system of traction instead of the steam tug and the power of men and horses. This led to a thorough study of the existing methods of hauling canal boats. It was found that in Europe two systems of electrical haulage had been worked fairly successfully for some time.

1. The system of Professor Léon Gerard, by which

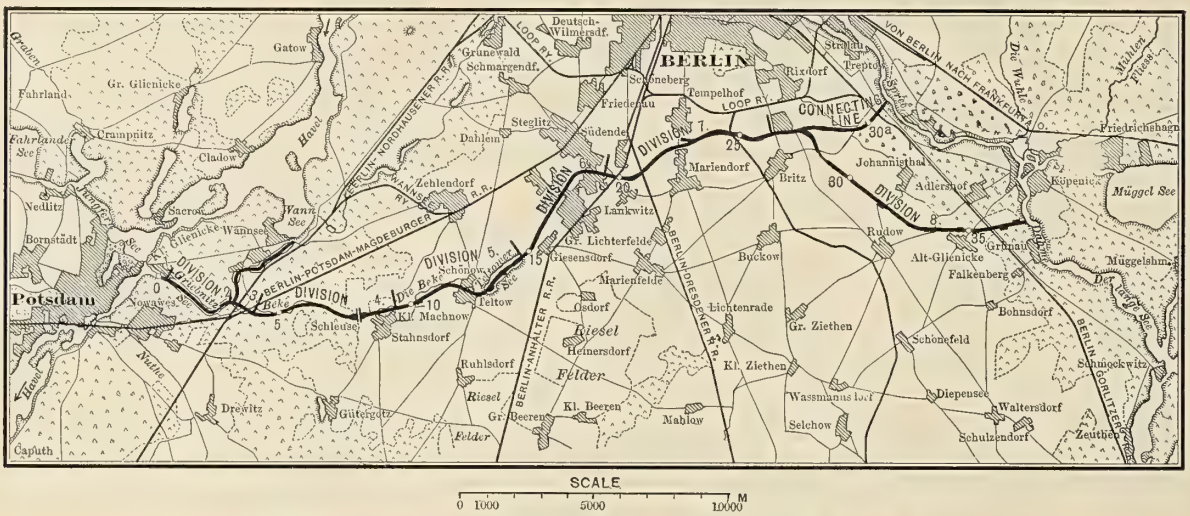


FIG. 1.—MAP SHOWING RECENTLY COMPLETED TELTOW CANAL, FOR DIVERTING TRAFFIC AROUND BERLIN.

the canal between Brussels and Charleroi in Belgium was operated until lately and which is still in use on the canal of Douai in northern France. See Figs. 2 and 3. The machine (cheval électrique) is practically an electric automobile using three-phase current and resting on four wide-rimmed wheels. It is fully described and a sketch shown in the September issue of Marine Engineering of 1902, so that further details can be omitted at this place. The difficulty, however, with this system, besides the expensive upkeep of the canal path, was that the man on the automobile had to watch the towed canal boat and at the same time steer his car, besides managing the brake, the rope, and the drum carrying it. Soon a Mr. Denèfle improved the former system by laying a regular railroad track and changing the automobile into a locomotive.

2. The second system referred to was the one designed by Mr. Koettgen, chief engineer of the well-known Siemens & Halske Company. It was practically tried and thoroughly tested during the year 1899 on the Finow canal, and is shown in Fig. 3. The electric trolley locomotive used has two axles, each carrying on the side next to the water a wide-rimmed wheel running directly on the canal path, while on the other side is provided a wheel running on a regular track. For this single track rails of about 13 1-2 pounds per foot have been used. The rope for pulling the barges was wound on a drum worked by hand power. The locomotive's weight was about 4,500 pounds, of which about 3,500 pounds are carried by the two wheels running on the track, which are also the drivers. The main item of interest is this unequal distribution of the weight in order to counterbalance the pull of the rope and to prevent the tilting of the machine. Extensive trials were carried on, among others with a barge of 250 tons displacement. The resistance was found to be 700 pounds at a speed of a little less than three statute miles per hour. The trials brought out the remarkable fact that the coefficient of utilization of this system of hauling, starting from the power at the wire, is about 60 per cent. The electric locomotive was built symmetrically so that it could be used both ways. It was thought sufficient to have the track on one side of the canal only and to exchange ropes when two locomotives met. The feasibility of this system was perfectly demonstrated by the trials of this first Koettgen locomotive.

The experience gained was incorporated in a new locomotive completed in 1900, which, however, was not subjected to any special trials, but sent to the Paris exhibition. As will be seen in Fig. 4, the wheels were simular to the first one. Instead of equipping the locomotive with one electric motor, as in the first, two were installed, one on each axle, bringing the weight of the machine up to 8,800 pounds and giving more adhesion to the rail, besides a better and more economical control. Another very important improvement was the adjustable sliding rope guide, by means of which the rope could be lifted over any obstacle between the locomotive and the barge if it was not excessively high. Before providing this guide it was frequently necessary to slip the rope altogether.

Besides the two systems of electric haulage actually tried there have been built or are prepared to be built three other systems having merit. The inventors are Rudolph, Vering and Feldmann.

Rudolph's system consists in a carriage of 2.75 tons weight running on an iron girder track and controlled from the towed barge; one motor for direct current is proposed.

Vering's electric locomotive (Fig. 5) uses three-phase current and has four inclined wheels, *AA*, on a single track driven by one motor, and like Koettgen's has a wide-rimmed plain wheel, *D*, on the water side of the track. To meet the pull of the rope the pressure on the four inclined wheels and thereby their adhesion can be increased. The locomotive weight is 2.5 tons.

Feldmann's locomotive (Fig. 6), weighing 4.8 tons, runs on light rails and has a roller resting against the third current-carrying rail from below preventing thereby any tilt of the machine. There are two motors; direct current is used.

Another unique system, originated by W. Fellenberg, may be mentioned here. The locomotive rests on two trucks having two axles each and being driven by 15 H. P. motors using three-phase current. All the eight wheels are drivers and therefore the total weight of the

machine (6 tons) is effective in pulling. The peculiarity of the system, however, consists in not using tow boats over the sections of the canal which cannot be provided with a track, but by letting the locomotive run over a slip on a pontoon, fastening it down and employing the machinery of the locomotive for driving the pontoon across the water, at the same time towing the freight barges. The propulsion of the pontoon can be by paddle-wheel, screw propeller, or by rope or chain. The latter is the one chosen by W. Fellenberg in the arrangement proposed for the Teltow canal.

There had also been made quite a number of trials with boats driven by trolley current transmission and storage batteries.

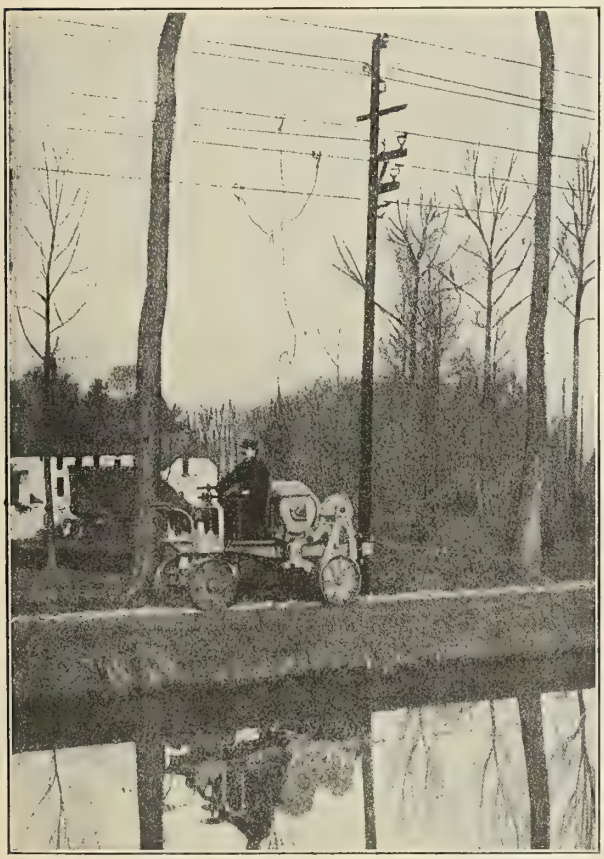


FIG. 2.—ELECTRIC TOWING AUTOMOBILE, LEON GERARD SYSTEM.

The Teltow canal authorities on close investigation found that no one of the existing systems of electric haulage was sufficiently developed and tried, to warrant its immediate introduction on the canal. In order to gather all possible up-to-date information it was therefore resolved during January, 1902, to advertise for a solution of the question on hand, holding out prizes ranging from $500 to $1,250. The conditions and data, technical as well as commercial, which had to be complied with, had been worked out in the most minute and thorough manner for the use of the engineering firms wishing to compete. The main points being as follows:

The canal is provided with paths of 6 1-2 feet width on both sides. There are seven bridges over which the locomotives can cross to the other side of the canal. The ascent of the path shall not exceed 1:20. The smallest radius of the canal line is 1,640 feet. There are three general classes of barges as per following table:

	Carrying Capacity Gross-tons.	Length Feet.	Beam Feet.	Draft Feet.
I.—Barge on system west of Berlin.	600	214	26¼	5¼
II.—Barge on system east of Berlin..	450	180	26¼	5¼
III.—Barge on Finow canal.....	170	132	15	4

The towing machine shall be able to tow one barge of the largest size, carrying its full load, at the rate of 2 1-2 statute miles per hour. The direct maximum pull at this speed is estimated to be about 3,300 pounds. The speed of the empty barges shall not exceed 3.12 statute miles, to prevent the damaging wash of the canal banks. Electricity is to be used as source of power, but the plant for generating and transmitting it was not to be the subject of the advertised proposition. The cost of 8,000-volt, three-phase current all along the canal can be assumed to be 2.87 cents per kilowatt hour. Other systems may be proposed. For the traffic calculations the average freight of the barges is to be taken at 65-70 per cent. of their full carrying capacity. Every fourth boat is to be assumed empty. This will sum up, for a yearly traffic of 1,500,000 gross tons of freight, to 1,025 barges of class I., 2,566 of class II., and 6,668 of class III., according to the usual percentage derived from the Berlin traffic. Besides there were given data for the highest and lowest number of barges per day, as the traffic is very unevenly distributed over the assumed 270 working days, and the capacity of the lock had to be taken into consideration.

The jury consisted of seven men of high standing and acknowledged experience. On May 1, 1902, there had been received 21 answers to the public appeal.

Ten of these proposals provided towing the barges the whole way through the canal by motor boats, the systems differing mainly in the electric current transmission. One reason for choosing tow boats probably was that the canal cuts through several lakes and that a substantial track for a locomotive across these lakes would be out of the question on account of swampy ground. On the other hand, by using tugs the banks were left free from any track and perfectly unhampered for loading and discharging the barges. This is a very important item, as it can be reasonably expected that within a few years the whole canal will be one continuous harbor. The writers of these ten propositions, however, have been given to grave deceptions as to the efficiency of the screw propeller, the difficulties of transmitting to boats power by overhead feed wires on a wide canal, and to the losses of energy in controlling the motors in as wide ranges as are necessary in this case. The maximum efficiency of a towing, screw-propelled boat, taking the current by a trolley from an overhead feed wire, can be assumed to be about 33 per cent. at an average pull. Increasing or lessening the pulling power makes the efficiency drop close to only 15 per cent. In case storage

batteries are used the loss is still greater, as another drop of about 25 per cent. between the charging and discharging of the batteries must be figured with. The efficiency of the electric trolley locomotive is considerably higher and it has been found to be about 36 per cent. for small, 60 per cent. for medium, and 65 per cent. for maximum power. The locomotive therefore uses less than one-half the current of the tow boat. This fact settled the question as to what method of traction to adopt for those parts of the canal which could be provided with a track. The next thing was to pick from the ten described locomotives the one offering the most advantages. Of these ten designs three had natural adhesion to the track by their own weight, while in seven the adhesion was artificially increased, the authors of the latter apparently thinking that the natural adhesion would not be sufficient to overcome especially the initial pulling strain. Among these seven proposals was one providing a rack and pinion mechanism; another one sought to increase the friction by spring power in a

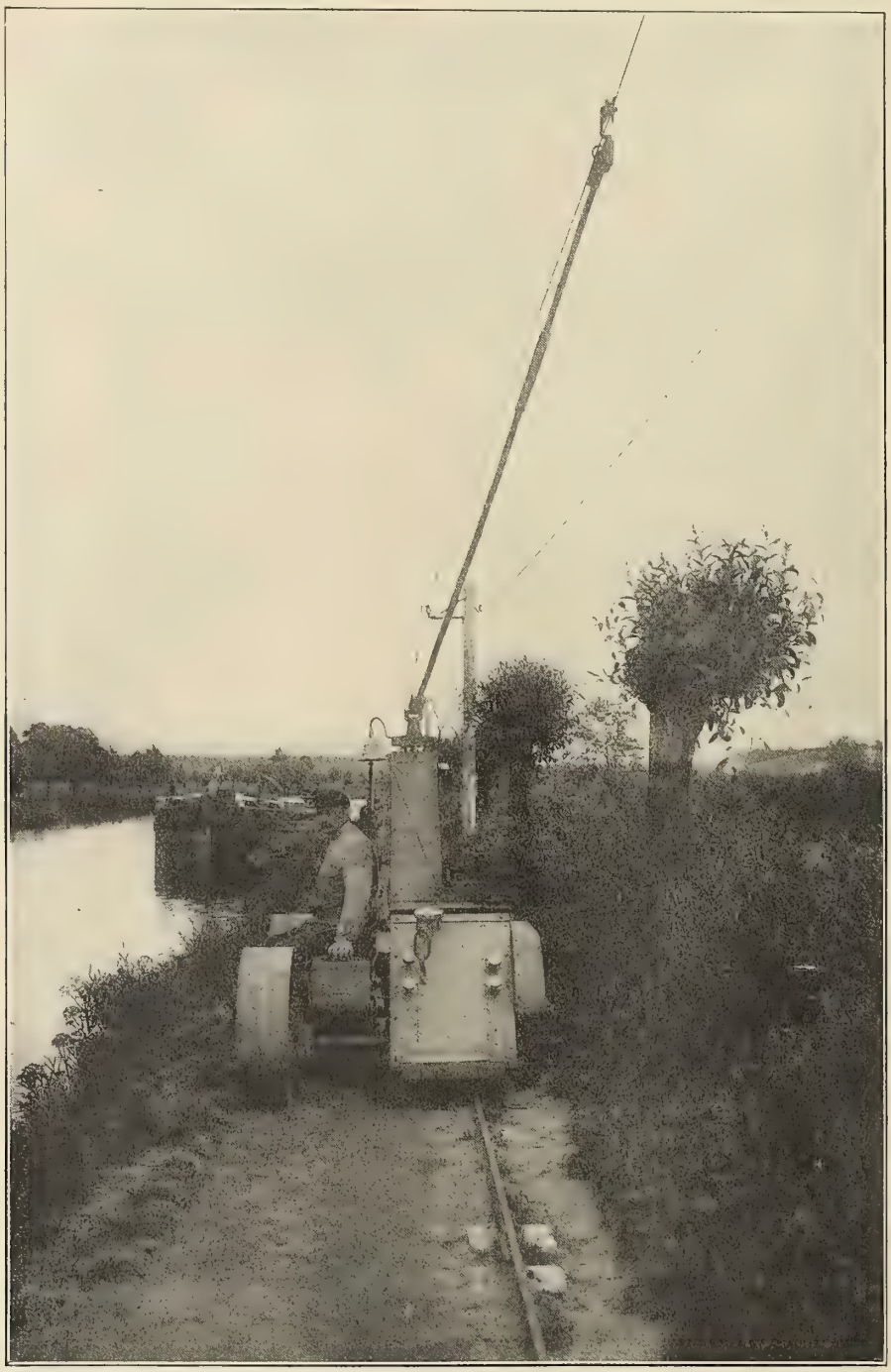


FIG. 3.—KOETTGEN LOCOMOTIVE NO. 1, ON FINOW CANAL.

however not sufficiently effective way. The other five designs use either the pull itself for pressing the wheels under an angle to the rail or else increase artificially the weight of the locomotive by strong magnets close to the rails. The general tendency was to keep the locomotive as light as possible for cheapening the building expense of the locomotive as well as of road bed and track, and increasing the adhesion artificially to the amount required.

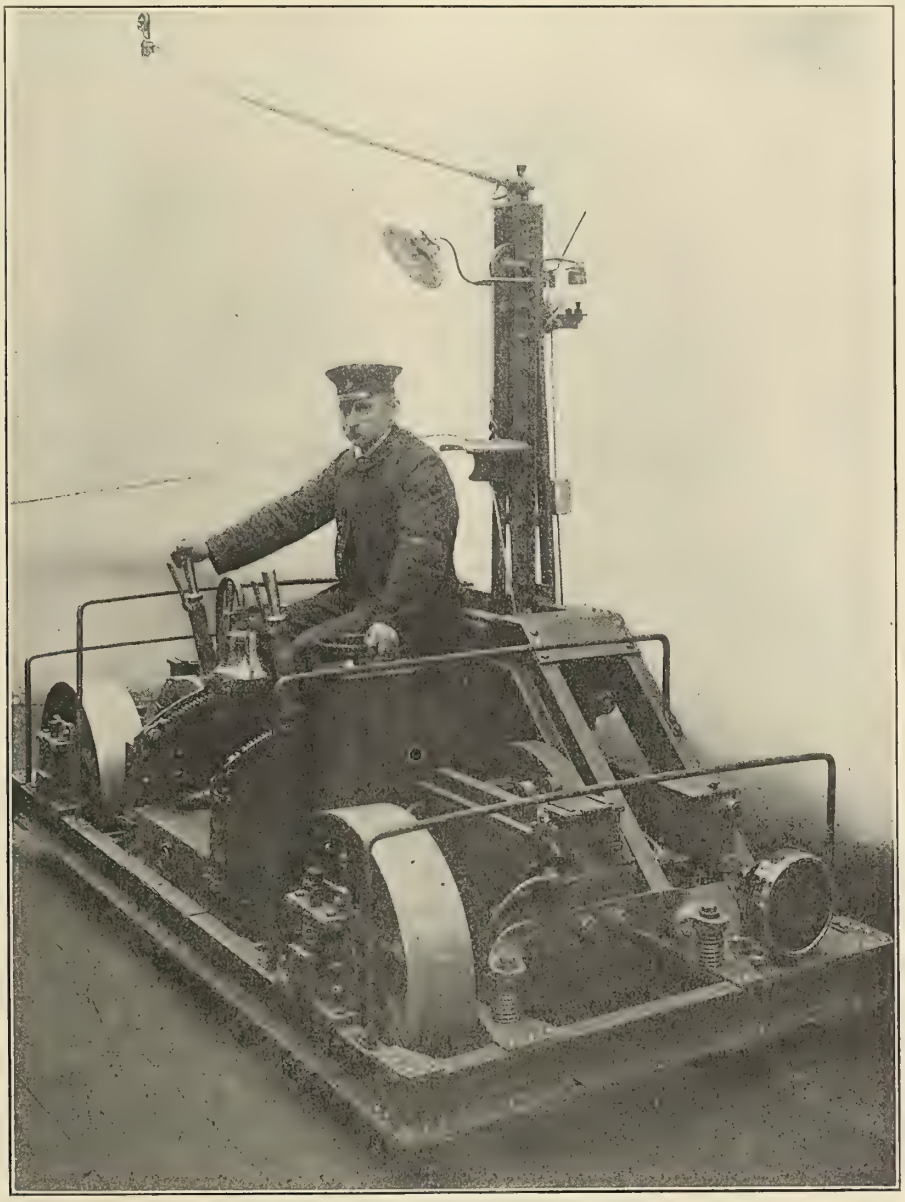


FIG. 4.—KOETTGEN LOCOMOTIVE NO. 2, SHOWING THE SLIDING ROPE GUIDE.

It is, however, to be doubted if a light-built, more or less complicated machine of the above character is the right thing for a canal hauling device. The handling of barges is very rough work, and the strain on the rope will be anything but uniform. Besides the locomotives are to be run by cheap men. Therefore, simple, easily understood machinery must be looked for, that will be kept in good working order without special care, and that will stand well the many jerks in service. The operation of the canal locomotive resembles that of the ordinary trolley street car. Everybody knows of the great difficulties and the unexpected heavy expense of the upkeep of the mechanical and electrical outfit of the street cars. The present task is, however, somewhat easier, as the canal locomotive will naturally not stop every few hundred yards, and the range of speed is considerably smaller.

As to the kind of current, eleven of the competitors proposed to use direct current and ten three-phase alternating current. Of these ten advocates of alternating current, however, nine also admitted the good, time-tested qualities of the direct current motor for traction purposes. The more complicated wiring of the two and three phase systems is especially felt at the switches. On

the canal the switches are of practically no importance, as there is no absolute need of any at all in the main line. For taking the locomotives out of the main track the trolley can be shifted by hand. The necessity of using tow boats for some parts of the canal is a strong argument in favor of direct current, as the storage batteries require this kind of electric energy for charging, and the transmission of two or three phase current to the tow boats by trolley is more complicated.

As to the methods of transmitting the current from the wire to the locomotive or boat, seven provide poles and rollers, as used on the street cars, and five use small trucks, running on the wire and being pulled along by the locomotive or tug by a light cable. Five authors advocate an arrangement like the trolley automobile invented by Lombard-Gerin. It consists essentially, as shown in Fig. 7, of a small carriage running on the feed wires, propelled by a separate small motor, keeping it always ahead of the towing boats and allowing comparatively free manœuvring sideways. Three of the locomotives have short levered, sliding contacts for taking the current.

Coming now to the financial and commercial part of the six best propositions, which received the prizes already mentioned, we will not consider the figures of the cost of buildings and machinery, the running expenses and the cost per ton mile ton of freight according to the ideas of the authors, but give these items brought to the same level in order to afford a fair comparison.

The authors differed somewhat in their figuring basis, especially as to the source and cost of current, although this part of the traction plant was practically eliminated in the public announcement by giving a fixed price for

TABLE I.

System.		Capital to be Invested.	Yearly Running Expenses.	Expense for Towing One Long Ton (2,240 pounds) of Freight One American Mile.
				Cents.
I. Direct current locomotives.				
a. Koettgen	*a.*	$275,000	$52 300	2.89
	b.	469,000	83 000	2.74
	c.	505,000	125,000	2.07
b. Feldmann	*a.*	334,000	55.600	3.05
	b	583.000	89 800	2.97
	c.	618,000	131 000	2.15
c. Rudolph	*a*	281,000	52.400	2.89
	b.	462.000	81.000	2.70
	c.	495,000	122,000	2.03
II. Three-phase current locomotives.				
a. Fellenberg	*a.*	264 000	50.800	2.82
	b	474,000	84,600	2.78
	c.	497 000	123 500	2 03
b. Vering	*a.*	205,000	46.300	2.54
	b.	371,000	77,200	2 54
	c.	386,000	114,400	1.88
III. Storage battery boats	*a.*	387 000	101.500	5 56
	b.	627.000	162.500	5.36
	c.	716,000	258.500	4.27
IV. Trolley boats with direct current	*a.*	306,000	75,800	4.19
	b.	452,000	116,800	3.84
	c.	500,000	187.500	3.05
V. Trolley boats with three-phase current	*a.*	295.000	79.400	4.35
	b.	488,000	129,000	4.22
	c.	555,000	207,000	3.40

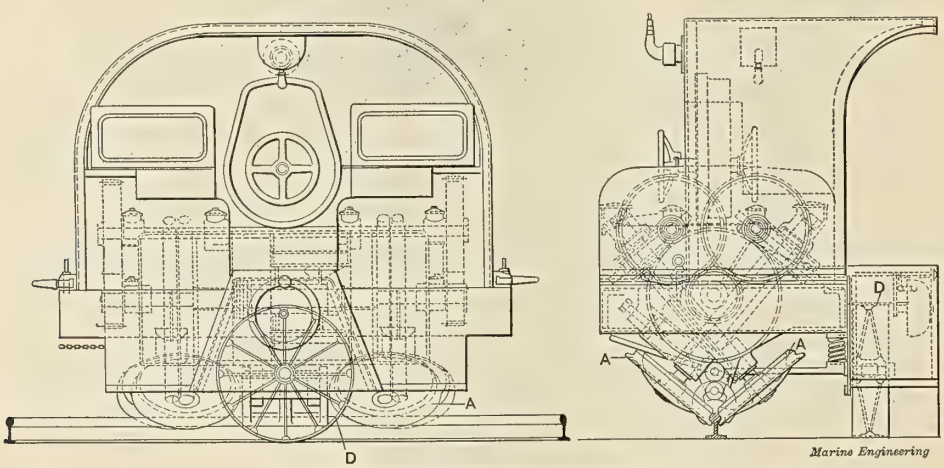


FIG. 5.—VERING'S ELECTRIC LOCOMOTIVE.

current to figure with. But some of the authors did not use this figure, but thought it essential for recommending their system to start from other suppositions. Therefore the government commission for looking into the canal traction question went over the prize work and changed the figures very carefully, bringing them to a common basis.

The following table, I., shows the results of these calculations. The figures are given (*a*) for one million tons of yearly freight traffic, (*b*) for two, and (*c*) for four and one-half million tons:

The table shows that the five locomotive systems do not differ materially in regard to their economy. The choice of which system to take will therefore turn on the question of simplicity, and certainty of the machinery, track, and power transmission.

The towing by boats, especially by those worked by storage batteries, is more expensive than by the locomotives, as could be expected from their low efficiency. It is, however, sure, that the economic conditions change favorably for the boats in case the yearly traffic is less than one million tons of freight. The smaller the traffic

the more favorably stand out the boat carrying storage batteries, even compared with the trolley boat.

In the following table, II., are given the percentages of the running expenses arranged according to their sources for the four most practical systems, and the yearly traffic (*a*), (*b*), (*c*), as before:

provide for enough men, locomotives, tow boats, etc., to take care of the maximum traffic. In order to make this large plant pay and ask reasonable towing taxes the barges could not be permitted to pass by the towing machinery and to use their own power or employ outside tugs to go through the canal.

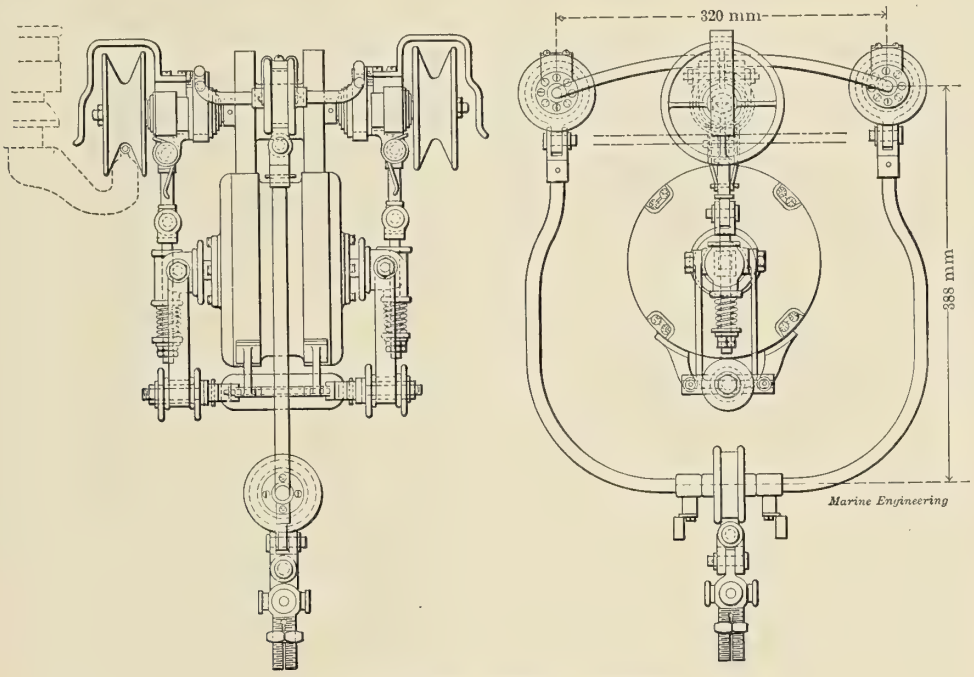


FIG. 7.—LOMBARD-GERIN TROLLEY AUTOMOBILE.

TABLE II.

System.		Expenses Originating from the Invested Capital, Interest, Sinking Fund, Renewals, and Repairs.	Management, Salaries, Materials, and Sundries.	Wages.	Current.
Direct current locomotives.	*a.*	42%	13%	26%	19%
	b.	46	11	24	19
	c.	33	11	33	23
Three-phase current locomotives.....	*a.*	46	13	23	18
	b.	50	10	22	18
	c.	36	11	32	21
Storage battery boats.....	*a.*	46	7	21	26
	b.	46	6	21	27
	c.	33	6	30	31
Direct current trolley boats.	*a.*	42	9	21	28
	b.	41	8	21	30
	c.	28	8	29	35

The county of Teltow applied for and received from the government the monopoly for electric hauling on the Teltow canal on May 7, 1901. This grant was necessary for two reasons: (1) The canal, and especially the lock, can only be utilized up to its full capacity during the rush, if the traffic is well regulated and crowding prevented. This is only attainable by obliging every barge entering the canal to use the hauling plant and allowing no stray boats to move about. (2) The county has to

As the result of the investigation the committee resolved to make some special trials with boats, the Koettgen and the Feldmann locomotives. This was decided upon for gaining more experience with this new matter and for collecting some desirable data. These trials were

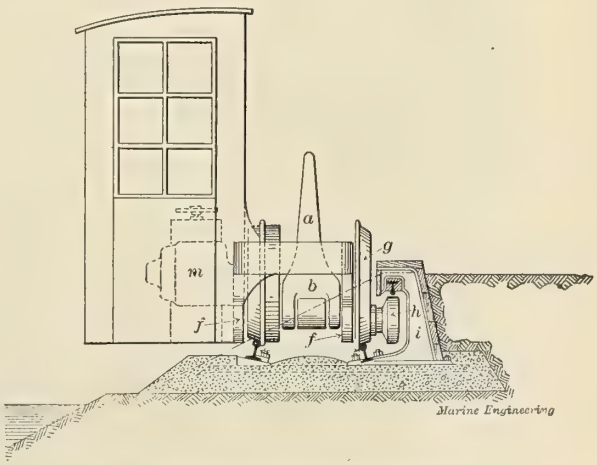


FIG 6.—FELDMANN'S ELECTRIC LOCOMOTIVE.

commenced during the fall of 1903, and those covering the main features have but just been completed.

The trials with the boats, following the Lombard-Gerin system, see Fig. 8, corroborated the high expense which was expected, so that the use of electricity has been

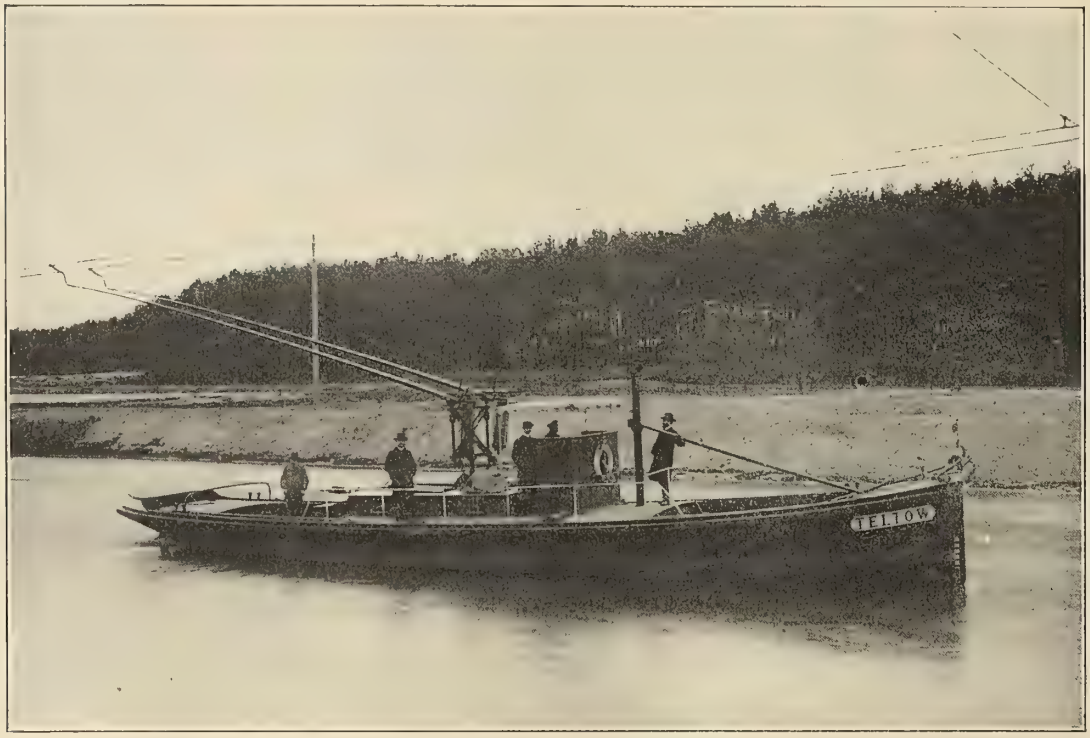


FIG. 8.—ELECTRIC TROLLEY TOWBOAT, BUILT FOR TRIAL ON THE TELTOW CANAL.

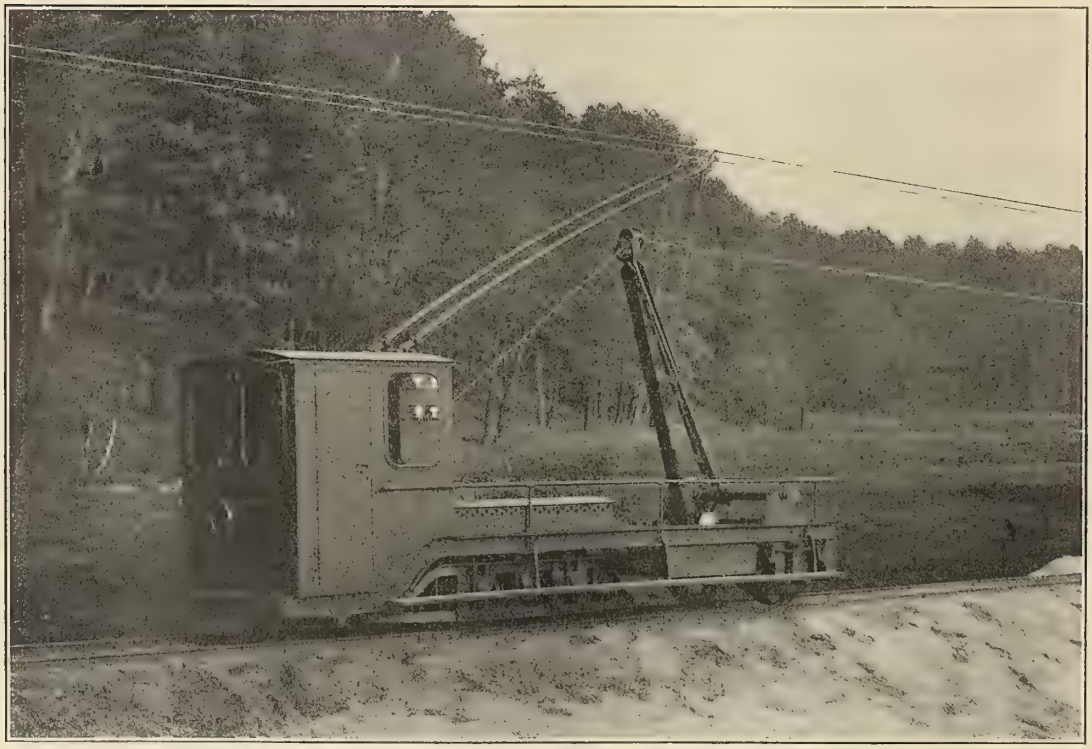


FIG. 9.—ELECTRIC LOCOMOTIVE FINALLY ADOPTED FOR TOWING ON THE TELTOW CANAL.

given up entirely for them. An alcohol motor boat was tried then in competition with a boat driven by a gas engine of the Ventzer Gasmotorenfabrik, having a producer gas generating apparatus on board. The latter boat has proved the best and will be adopted.

As to the locomotives, the two interested concerns merged into one, the Siemens-Schuckert Werke, and it was decided to experiment only with the Koettgen locomotive, which had received the first prize. A locomotive of 2,200 pounds pulling power, see Fig. 9, having a weight of about 14,000 pounds, was built to run on a regular double track of rails of 15 pounds per foot and 39.37 inches (1.0 meter) gage. The locomotive has three axles, the two front ones being united in a separately turning truck. Each of these two latter axles is driven by a train of gears and an independent motor of about 10 H. P. The drum for carrying, winding, and unwinding the tow rope, and also the swinging lever, with which this Koettgen locomotive No. 3 was provided to lift the rope over the usual obstacles, were driven by separate electric motors, easily controlled by the motorman from his stand. Direct current of 550 volts was transmitted by the regular trolley car pole. The trials which took place on the Teltow canal, were conducted according to an elaborate programme, and the locomotive has come up to all expectations so well and even surpassed them, that it can be put into service without any hesitation.

FIG. 11.—VIEW ON THE TELTOW CANAL, SHOWING ELECTRIC LOCOMOTIVE TOWING BARGES.

As the canal passes not far from the Potsdam magnetic observatory the return current is not carried through the rails and copper binders on this section of the line, but by a second overhead wire and a second trolley pole. This arrangement is adopted for a little over 6 miles.

rope lifted up. An experimental grade of track was built for determining the climbing qualities of the locomotive.

For 2,000,000 tons of freight 15 locomotives are necessary to run on schedule, the tows leaving every 90

FIG. 12.—TOWS PASSING EACH OTHER IN OPPOSITE DIRECTIONS, ILLUSTRATING THE ROPE-LIFTING DEVICE ON THE LOCOMOTIVE.

For the electric traction the canal is divided into four sections, each terminating at a bridge. Here the barges change the locomotive and the latter crosses to the other side of the canal to return. This arrangement was found to work better than to let the locomotives run all the way through.

The running expenses, as given in the prize projects, show evidently that under the assumptions considered there is no profit whatever; the latter tests, however, brought out the remarkable result that the number of barges forming a train could be doubled and the power of the locomotive reduced from 3,300 pounds to a little over 2,400 pounds.

It was further corroborated by experiments (see Fig. 10) that the speed of about 2 1-2 miles is the most economical. Below this speed the current is not appreciably less, while above it rises quickly. For instance, at 2.81 miles speed, the outlay for current is 20 per cent. more, while the total time of going through the canal is only reduced from 10 hours 15 minutes to 9 hours 20 minutes; that is a gain of only 9 per cent.

The length of the tow rope having the minimum resistance of the barge was determined to be about 80 yards. The steering of the barges against the oblique pull of the tow rope presented no difficulty whatever, as the bargemen understood at once how to set the helm. A tow is clearly illustrated in Fig. 11. Fig. 12 demonstrates the working of the rope lifting device on the locomotive. It shows the locomotive with a barge just before passing on the outside of another one, with the

minutes. Twenty have been ordered, however, to be prepared for emergencies. For 3,000,000 tons of freight

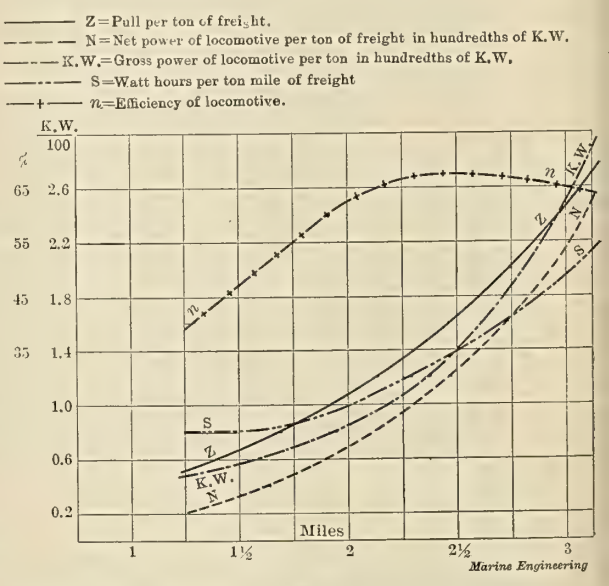


FIG. 10.—TOWING DATA FROM TRIALS ON THE TELTOW CANAL.

27 locomotives will answer the requirements; the tows leave every 70 minutes. For 4,000,000 tons 34 locomotives will be operated, the tows being 50 minutes apart.

TABLE A.—COST OF ELECTRIC HAULAGE PLANT ON THE TELTOW CANAL.

For Yearly Traffic in Gross Tons of Freight.	2,000,000 Tons.	3,000,000 Tons.	4,000,000 Tons.
1. Forty-four miles of roadbed and track, 30 switches, and 4 bridges	$317,500	$317,500	$317,500
2. Fifty-five miles of electric equipment	85,000	85,000	85,000
3. Locomotives of the required number; 2,650 lbs. maximum working pull at 2½ miles speed; 3 axles, weight about 14,300 lbs. apiece	57,200	77,200	97 300
4. Locomotive sheds and repair shops	10,700	10,700	10,700
5. The required number of 75 H. P. gas engine tugs, and slips	97,600	114,100	147,800
6. General expenses for projects, prizes and cost of experiments	32,300	32,300	32,300
Totol	$600.300	$636,500	$690,600

TABLE B.—RUNNING EXPENSES FOR ELECTRIC HAULAGE PLANT ON THE TELTOW CANAL.

For Yearly Traffic in Gross Tons of Freight.	2,000,000 Tons.		3,000,000 Tons.		4,000,000 Tons.	
	Total.	Cents per Mile Ton.	Total.	Cents per Mile Ton.	Total.	Cents per Mile Ton.
1. Electric current for locomotives	$9,050	0.234	$12,350	0.214	$14.400	0.187
2. Anthracite for producer gas boats	1,250	0.031	2,860	0.031	2.500	0 031
3. Wages	18,850	0.488	23,840	0.413	30,700	0.402
4. Upkeep and repairs	11,400	0.296	12,900	0.222	15,000	0 195
5. Interest and sinking fund	27,100	0.702	29,200	0.498	31,200	0.402
6. Depreciation	10,700	0.277	11,950	0.210	13,800	0.179
Total	$78,350	2.028 cents.	$92,100	1.588 cents.	$107,600	1.396 cents.

TABLE C.—RUNNING EXPENSES FOR STEAM TUGS INSTEAD OF THE ELECTRIC LOCOMOTIVES.

For Yearly Traffic in Tons of Freight.	2 000,000 Gross Tons.		3,000,000 Gross Tons.		4,000.000 Gross Tons.	
	Total.	Cents per Mile Ton.	Total.	Cents per Mile Ton.	Total.	Cents per Mile Ton.
1. Steamer coal for tugs	$11,800	0.308	$17,750	0.308	$23,650	0.308
2. * Anthracite for gas boats	1,250	0.031	1,860	0 031	2,500	0.031
3. Wages	26,500	0.685	36,000	0.624	49.300	0.636
4. Upkeep and repairs	13.900	0.363	18,800	0.324	24,200	0.312
5. Interest and sinking fund	13,400	0.347	17,150	0.296	21,700	0.281
6. Depreciation	9,300	0.242	12,140	0.211	15.550	0.202
Total	$76 150	1,976 cents.	$103,700	1.794 cents.	$136,900	1.770 cents.

*For convenience and direct comparison the gas engine boats remain in the calculation.

As soon as 5,000,000 tons are exceeded the plant will be in operation day and night during the rush season.

In the opposite tables are compiled the figures constituting the basis for the plant as authorized and building on the Teltow canal at present. It may be remarked that in the running expenses the empty barges have not been considered, to be on the safe side. The figures per ton mile of freight appear rather high compared to the general idea of steamship freight on canals, which is in Germany about 1.2-1.6 cents per ton mile. But it must be kept in mind that the monopoly obliges the county of Teltow to be prepared for the maximum traffic, and to have at all events an adequate plant. The interest of the sums spent for the large rolling stock, etc., increase the running expenses considerably. Moreover, the men have to be kept throughout the year, while during certain periods quite a number of them will have little to do.

In the tables is also shown the financial effect of a plant consisting of steam tugs alone. The first outlay is, especially for a small, initial traffic, considerably lower than for the locomotive traction system. The running expenses are not far from those of the locomotives in the beginning; but while the latter drop with the increasing traffic, the former stay nearly the same. Therefore the locomotive system is the more economical one in the long run. Furthermore, it is also more desirable for two reasons: first, the tugs being practically banished from the water, the road is freer for the barges—a larger number can enter the canal without crowding; second, the upkeep of the canal bed and banks is appreciably cheaper, because, in the absence of tugs, the damaging effect of the screw propellers, bow and stern waves, etc., is entirely avoided.

For the photographs, diagrams, and most of the data, I am indebted to Mr. Erich Block, superintending engineer of the Teltow canal, and to Mr. Koettgen of the Siemens-Schuckert Company.

New Steamships for the Hamburg-American Line.—Two ships, of the intermediate type, of the largest dimensions, are now under construction for the Hamburg-American line. They are to be twin-screw vessels of about 17 knots sea speed, enabling them to make the trip between New York and Plymouth or Cherbourg in about 7 1-2 days. The innovations introduced by this company in former steamers will be found on the new vessels, such as the grill room, restaurant, and gymnasium. Each ship is also to be fitted with Turkish baths and passenger elevators through all the five decks on which there are passenger accommodations. The *America,* which is being built by Harland & Wolff, Belfast, will be ready for service next summer. Her dimensions are: Length over all, 700 feet; breadth, 74 feet; depth, 53 feet; gross tonnage, 23,500 tons; displacement, about 35,000 tons; cargo capacity, 15,000 tons. The other vessel, the *Kaiserin Auguste Victoria,* will be ready in the spring of 1906. She is being built by the Vulcan Shipbuilding Works at Stettin, Germany. Her dimensions are: Length over all, 705 feet; breadth, 77 feet; depth, 53.9 feet; gross tonnage, 25,000 tons; displacement, about 40,000 tons; cargo capacity, 16,000 tons.

TWELFTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The twelfth annual convention of the Society of Naval Architects and Marine Engineers was held in New York on Thursday and Friday, November 17 and 18, 1904.

The first session was called to order on Thursday at 10:25 A.M., with the president, Francis T. Bowles, in the chair. The first business was the report of the secretary-treasurer, which was receievd and adopted. The statement of resources and liabilities shows that the society's finances are in most excellent condition. The total resources are $21,072.10, while the liabilities are none. The council presented the following lists of applicants for admission to the various grades of the society; the names were read and upon motion the applicants were unanimously elected. The membership of the society on November 15, 1904, was 844, a slight decrease from a year ago.

Honorary Member, 1.—Sir William White, K.C.B., etc., late chief constructor, British navy.

Members, 19.—Lawrence Stowell Adams, naval constructor, U. S. Navy, Union Iron Works, San Francisco, Cal.; James Donald, naval architect, New York Shipbuilding Company, Camden, N. J.; James Oliver Duke, assistant superintendent, Kensington Shipyard Company, Philadelphia, Pa.; Edward Stamford Samuel Hough, engineer surveyor, Bureau Veritas, San Francisco, Cal.; Frank Jeffrey, vice-president, Union Iron Works, San Francisco, Cal.; Charles M. Jones, draftsman, Municipal Government, New York city; William Joseph Luke, naval architect, John Brown & Company, Ltd., Clydebank, Scotland; Henry Lysholm, superintendent of hull construction, New York Shipbuilding Company, Camden, N. J.; John H. Macalpine, naval architect and consulting engineer, 4504 Pine street, Phliadelphia, Pa.; Percy Howe Middleton, vice-president, H. I. Crandall Company, 102 Bates street, East Boston, Mass.; William Brackett Stearns, naval architect, Marblehead, Mass.; Warren Taylor Berry, assistant superintendent marine construction, New York, New Haven, and Hartford Railroad Company, New York; William J. Drew, instructor in naval architecture, School of Mechanical Arts, San Francisco, Cal.; William Neill Howell, superintending engineer, Eastern Shipbuilding Company; Horace Thompson Sloan, Jr., chief draftsman, floating equipment, Pennsylvania Railroad Company, Jersey City, N. J.; Charles Gordon Curtis; Amasa Trowbridge, adjunct professor mechanical engineering, Columbia University, New York; James C. Wallace, president American Shipbuilding Company, Cleveland, Ohio; George Warrington, superintendent construction, U. S. Lighthouse Establishment, Washington, D. C.

Promotion from Associate to Member, 8.—John D. Beuret, naval constructor, U. S. Navy, Bureau of Construction and Repair, Navy Department, Washington, D. C.; Willis Gorman Dodd, president, Union Iron Works, San Francisco, Cal.; Thomas Murritt Dick, professor of mechanical engineering, College of Agriculture and Mechanical Arts, West Raleigh, N. C.; Godfrey L. Smith, draftsman, Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.; Charles Franklin Willard, instructor of marine engineering, Massachusetts Institute of Technology, Boston, Mass.; George Eugene Barrett; Theodorus S. Bailey; Henry Capdevielle.

Associates, 11.—William Allison Fuller, estimate clerk, New York Edison Company, 55 Duane street, New York, N. Y.; Alonzo Gartley, general manager, Hawaiian Electric Company, Honolulu, H. I.; Henry S. Grove, president, The William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.; Andreas Petrus Lundin, Pacific Mail Steamship Company, San Francisco, Cal.; Fred. McQuesten, vice-president, The George McQuesten Company, 27 Kilby street, Boston, Mass.; Louis Horatio Turner, surveyor, Bureau Veritas, San Francisco, Cal.; Fields Seeley Pendleton, manager, Pendleton Brothers, Belfast, Me.; Hans Georg Hibbinghaus, Commander Imperial Navy, naval attaché, German Embassy, Washington, D. C.; Edward Murray Speakman, engine daftsman, Fairfield Shipbuilding Company, Glasgow, Scotland; William Culver Davis, mechanical and constructing engineer, 242 Donaldson avenue, Rutherford, N. J.; James Speers Dickie, draftsman, transport service, San Mateo, Cal.

From Junior to Associate, 1.—Axel E. Zetterman.

Juniors, 9.—Reuben B. Clark, naval architect, E. H. Godshalk & Company, Philadelphia, Pa.; Harold Mason DeGraw, draftsman, office of superintending constructor, Newport News Shipbuilding and Dry-Dock Company, Newport News, Va.; Walter Cook Keenan, draftsman, Department of Construction and Repair, Naval Station, New Orleans, La.; Everett Parker Lesley, graduate student, Cornell University, Ithaca, N. Y.; Granville Smith, hull draftsman, Maryland Steel Company, Sparrow's Point, Md.; Arthur Osborne Roberts, draftsman, Bureau of Construction and Repair, Navy Department, Washington, D. C.; John Hilbrish Well, secretary, The Matthews Boat Company, Bascom, Ohio; N. L. Snow; Arthur H. Sherwood.

Promotion from Junior to Member, 3.—Charles H. Godbold, Jr., draftsman, Union Iron Works, San Francisco, Cal.; Robert Stanley Height, assistant to superintendent, Old Dominion Steamship Company, New York, N. Y.; Clifton Yeomans, draftsman, Union Iron Works, San Francisco, Cal.

Admiral Bowles then delivered the presidential address, pointing out the fact that the year was notable because of the Russo-Japanese war. Its most vital factor was the command of the sea in eastern waters by the Japanese, who could not have entered upon the conflict at all had they not had a highly efficient and powerful navy. Referring to the *Slocum* disaster, the admiral declared that it would undoubtedly result in revision of the existing laws and rules of the steamboat inspection service, but that the matter must be carefully handled because of the many commercial and legal points involved, by no means least being the consideration of the adoption of non-combustible materials on vessels. The shipbuilding returns, he said, for large vessels for ocean traffic had been most unsatisfactory, only one such craft being on the ways; on

the contrary, the returns from the lake region indicated a brisk revival after the year's stagnation. The work of the congressional commission had done one excellent thing, the admiral thought, for the people as well as the technical men, for through the acts of congress ordering war vessels built which had no superiors anywhere in the world, it had shown first, that we can have a navy if we want it, and second, that in the same way we can have a proper merchant marine.

Upon the recommendation of the council all the present officers of the society were re-elected.

THE PRESIDENT: Gentlemen, I would like to say to you that the council at its last meeting adopted a vote asking the executive committee to prepare and present a revision of the constitution and by-laws of this society, particularly with regard to the election of officers and members of the council, the object being to provide some progression in the election of officers in a manner corresponding to that customary in other societies. The chair would especially be gratified by adopting such a change, as the present method of election of officers seems rather crude.

In the absence of the author, the first paper was read by the secretary.

SIMPLE METHODS IN WAR SHIP DESIGN A NECESSITY.

BY GEORGE W. DICKIE, ESQ., MEMBER OF COUNCIL.

ABSTRACT.

Since presenting a previous paper on this subject the author is more than ever impressed with the necessity of decreasing the number of complicated mechanisms in the equipment of war ships, especially in view of the fact that recently the equipment of a war ship has become much more involved. The scheme presented and illustrated by a set of plans is that a central passage be worked in the entire length of the ship, directly under the protective deck, and that this passage contain the pumping, ventilating and heating, and the communicating systems and electric cables of the entire vessel. Particular stress is laid upon the fact that in the present arrangement the connection by means of manifolds of, say, a fire pump to the bilge and boiler feed lines, is very inefficient, and that each pump should be designed for but one purpose. With this in view the drainage system is carefully worked out and simplified in the proposed scheme. Other simplifications proposed are the grouping of auxiliaries in a separate compartment, arrangement of steering gear, stowage of boats and coaling appliances. Throughout, the desire of the writer, who has had much experience in the design and construction of war ships, has been to reduce the number and intricacy of the necessary auxiliary mechanisms.

DISCUSSION.

NAVAL CONSTRUCTOR D. W. TAYLOR: Mr. President and Gentlemen: Personal remarks in the discussion of a technical paper before a technical society are clearly out of place. The papers which the authors give us are fair game for discussion—either praise or blame—but the personalities of the authors should, as a rule, not be mentioned. I think, however, in this case that we are somewhat warranted in departing from that very wise rule. Any one who did not know Mr. Dickie, and who read this paper, would regard him as a sour, sneering pessimist. Those of us who do have the pleasure of his acquaintance know that on the contrary he is a most genial optimist, full of the the milk of human kindness, and effervescing at times with wit and humor. In fact, when this paper has been carefully read, it will be found that Mr. Dickie has been unable, in many places, to keep down his optimism.

The title of this paper appeals to all of us—"Simple Methods in War Ship Design a Necessity." We all agree with the title and many of us preach it, particularly for the apparatus belonging to other people. Mr. Dickie has taken up in detail a number of items in connection with men-of-war—too many to discuss in detail—and what I have to say will be restricted to those features which, as a rule, are handled by the corps to which I belong.

Consider first Mr. Dickie's drainage scheme. That certainly has the great merit of simplicity; although I notice that the apparatus which he proposes to fit replaces only a part of the drainage now fitted. I sympathize very much with Mr. Dickie in his desire to simplify drainage, as I have preached the same means for many years with poor success; but I must say that I cannot agree with him as to the details of his method. Personally, I think the way to simplify drainage is to leave out about two-thirds without making any radical change in present systems. Suppose that a ship fitted with Mr. Dickie's scheme—a first-class battleship—should graze one of the uncharted rocks which bob up now and then and frequently do a great deal of damage: without damaging the structure of the ship as a whole or interfering with the propelling apparatus or disabling the ship in any way, it would probably knock a very large hole into Mr. Dickie's subway for drainage. The result would be that the captain of that ship would come into port as soon as possible and report that it was simply impossible for him to get a drop of water out of his ship except by bailing, and I am afraid that if there were other ships fitted that way they would probably be altered to the present complicated system.

Now, Mr. Dickie proposes to use a central passage for ventilation. The objection which he raises to the present system, on page 9, are very few really. He says if any ventilation is required over the whole ship every fan must be in operation to get it, although the amount required may be very little. The condition requiring very little ventilation is one which seldom arises.

He also objects to inlet cowls being fitted all over the upper decks. The fitting of these inlet cowls is a step in the direction of simplicity. It would not be very difficult to supply this independent system of fans with a supply main which led up in the superstructure, but it is much more agreeable to lead the air direct down to them. The great advantage of the present system which is pointed out by Mr. Dickie, is that it avoids piercing water-tight bulkheads with ventilation tubes with their complication of automatic valves, which, I believe, are supposed never to work, and the resulting danger to the ship. That was a very real and serious danger, and has been gotten rid of, not only in our service, and certainly in the English service, but I think

practically in every service in the world now, by fitting a number of electric ventilating fans. That could not be done until electricity was used for ventilating fans almost exclusively, because it would be practically impossible to fit a large number of small steam fans all over the ship. The network of steam and exhaust pipes would really be prohibitive.

Mr. Dickie proposes to use the central passage for ventilation. That is a case where his optimism crops out. He believes that nothing ever could or would happen to the central passage, and that he could use it with perfect safety. As a matter of fact, the central passage runs nearly the whole length of the ship, over 400 feet, and in places it dips down in the neighborhood of the keel; it is close under the protective deck nearly everywhere, and is undoubtedly subject to damage, and we cannot proceed on the assumption that it will not be damaged. People who are designing men-of-war have necessarily to be pessimists; they have got to assume that unpleasant things will happen and they have got to endeavor to provide for them. With Mr. Dickie's system there is no water-tight subdivision as long as the ventilation is in operation. Every compartment in the ship is in communication with every other compartment. He fits valves by which it can be shut off, and I presume the attendant in the central passage who has to do a good many other simple things, is to work these valves. I am afraid that attendant will have a job which is a good deal more difficult than the job of the slave of the lamp that we read about in the "Arabian Knights." The slave of the central passage has not only to work these valves, but has to turn on hot air and cool air for twenty or thirty state rooms, and also provide hot water at the desired temperature at each bath.

But to come back to Mr. Dickie's present system, there are a few other objections to it apart from the objection to the danger of the water-tight subdivision. In the first place, the fans are all fitted well forward, while the bulk of the air is utilized aft. The engine rooms and the dynamo rooms require probably more air than all the rest of the ship put together. This means that the air must be forced a long distance through this central passage, which has a good many pipes and other obstructions in it, and not well adapted for an air vent. Incidentally the slave of the central passage would be working in a gale of wind all the time. The pressure that he proposes to use of one ounce would undoubtedly cause a great deal of trouble if it were maintained in the central passage, for the reason that air escaping from a pressure of one ounce moves with great velocity —a great deal more than the 2,000 feet per minute which we generally consider. It must be put in ventilation ducts. The result would be a very serious disturbance of the people on board by the whistling of the air. Incidentally, there would be a good deal of waste of power. The pressure against which our fans work now seldom reaches as high as five inches, which is 5-9 of an ounce, a little over half of what Mr. Dickie proposes.

Another objection to this system is this: Mr. Dickie says on page 8: "More than half of the middle length of the ship under the protective deck is full of heated surfaces to something like 300 degrees." He then shows how he proposes to remove that heat, a proposition which was not adopted. This ventilation passage will act very effectively as a remover of a good portion of the heat. This central passage, which is threaded between the boilers at a temperature of 300 degrees, will undoubtdly be very hot. I think the central passages we have now on one or two ships which are not in close contact with boilers are by no means cool. In the tropics, where ventilation is most needed, we have very great complaints in one or two cases where the air for ventilation was delivered at a temperature only three or four degrees higher than that of the atmosphere. I remember the case of a monitor particularly, where there was very strong condemnation of the ventilation, and it was found that the temperature in the quarters was only three or four degrees above the temperature of the outside air (there is no doubt that this air will be delivered in the quarters at more than three or four degrees above the temperature of the outside air) and the first time that ship made a cruise in the tropics and came back there was a better ventilation system put in.

There are a few other minor objections to Mr. Dickie's system, any one of which would prohibit it. There is danger, by the bursting of a steam pipe or boiler, of damage being done to the central passage and vicinity, causing the central passage to be full of hot steam, which would disable the whole ship until the steam was gotten under control and the central passage cooled down. But there is a much more serious danger than that which has been brought into prominence by recent events. Mr. Dickie proposes to supply this central passage by a large duct which leads up just under the pilot house and has no protection. Well, the fumes of modern, high-explosive shells are deadly. If persons are exposed to strong fumes they are killed instantly; if to rather dilute fumes, simply stupefied. A single shell exploding in Mr. Dickie's duct would either kill or stupefy two-thirds of the people on the ship, and it would be some time before those who were not killed would recover from the effects. I think that alone, for a man-of-war, would prevent the adoption of Mr. Dickie's central passage idea as regards ventilation.

I notice on page 12 Mr. Dickie makes the remark in connection with a certain report of tests of a power door—he says: "It is stated that the door tested, as compared with the other, was simpler in construction, was tight, would stand ordinary neglect better, but would not stand gross neglect so well," and he considers the construction of the words quite hard to understand. I fully agree with him in that respect; but the words are Mr. Dickie's words, and not the words of the report. Mr. Dickie has paraphrased the report, and I will read you now the actual wording to which he refers, substituting the harmless terms "white" and "black" for the actual names of the doors in question:

"The white door as compared with the black door has the great advantage of simplicity; it can be made absolutely water tight against thirty-five feet head more readily; but would probably not show superior water tightness in service; it does not provide as completely against possible contingencies as the black design; it will require less care to keep it in first-class order, but will suffer more if given gross neglect."

Mr. Dickie, like all the rest of us, would like to get rid of voice tubes, and he says that the telephone has been brought to such perfection that there need be no doubt as to its reliability on board ship. That was a matter a little out of my line, but I am well aware of the fact that officers who have charge of such matters have been experimenting for years in the hope of getting a reliable telephone for use on board ship, and they do not admit yet that they have succeeded. Mr. Dickie's optimism is, I think, a little ahead of the actual state of the art. There are installed upon the most recent cruiser two telephones of a new design, which are supposed to be the best obtainable now. In conversation with an officer who was on the trial, I asked him how these telephones worked. They were put in for trial. He said that at times they worked perfectly. At other times they were absolutely unintelligible. He said that the people working them apparently were not quite sure of the cause of the trouble. I have no doubt that a telephone will come for use on board ship, and it is very much needed, because, on one of these 500-foot ships particularly, voice pipes are very inefficient.

There is one other matter Mr. Dickie tells us as regards several items that he has given careful attention to. I do not believe he did that as regards the proposition for coaling ships. If the problem of coaling ship was simply to get the coal over the side, and if the ship was floating in a sea of coal, I think Mr. Dickie's plan would probably work very well; but it does not apply to actual conditions. In the first place, the apparatus which he shows in Plate 4 will not fit into place. The center line of the bucket is between seven and eight feet, I think, out from the side of the ship, and the track would certainly have to be braced; in fact, he shows braces. These braces would have to be rigged by a brace seven or eight feet long and probably two or three inches in diameter, which would not be very easy to handle. He would have to provide an outfit of derricks and other gear in order to rig his coaling plant. This projection extends but seven or eight feet beyond the side of the ship, and it was evidently impossible to carry the bucket much further off or further away from the side of the ship; when you allow for the fact that the barge must have some clearance, means that the bucket commands only the extreme edge of the coaling barge. The barge may be thirty feet wide. The result is that to get coal into the bucket it will have to be transported some distance by shoveling, or wheeling, or some method, and I do not believe that it would be loaded quite as fast as Mr. Dickie thinks. Incidentally, this projection from the side of the ship and between the barge sticks up some distance above the water when it is light, and there would be very serious danger of wiping the whole thing off the first time the ship was coaled. These are minor matters, and with great care and skill it is possible that the outboard turrets could be made to work.

Now, Mr. Dickie gets coal over the side of the ship and dumps it into a hopper. The real difficulty with coaling a man-of-war is due to the fact that they have a large number of bunkers and that it is necessary to fill the bunkers quite full. That means you cannot simply dump the coal into the bunkers; it has to be trimmed into the bunkers more or less. There has been bitter complaint about trimming coal in bunkers. Apparently human flesh and blood cannot stand trimming coal more than a very short distance down in a bunker. That is universally agreed upon by the people who go to sea. Well, the result has been that with our ships at present we use a large number of coaling scuttles. On a ship such as Mr. Dickie refers to we have twenty-five or thirty on a side. Naturally the more coaling scuttles you have in your bunkers the less trimming of coal is necessary. You simply dump the coal through the most convenient scuttle. When that condition arose there were bound to be very great difficulties in getting coal trunks down from the upper decks to the berth deck level, to get the coaling scuttles into the berth deck. There are all sorts of things in the way. The ship is full of a large number of fittings, and in addition to that the upper deck is not an open, clear deck; it is interspersed with vents and ventilators and a number of other things, and the result was that instead of attempting to run twenty-five or thirty fixed or portable coaling trunks, portable coaling trunks were used between decks, but they were very difficult to stow.

The present system, which is just being tried in the navy, is to feed the coal down through two decks in comparatively large quantities from five or six hatches on the side, the hatches being also used as skylights. When it reaches the berth deck level, the coal being delivered in bags, the bags are transported to the nearest scuttle and dumped. Experience with dividing the coal on the upper deck indicates that if the coal can be fed down through the hatches there is no difficulty in separating it and dumping it on the berth deck as rapidly as required. There are, of course, objections to this system, as to every other, which I shall not go into.

Now, what does Mr. Dickie do? Instead of twenty-five or thirty coaling trunks he has just three on each side. If you look at his plan and the plan of his protective deck, you will see that using this coaling scheme it would be necessary in some cases to trim the coal from sixty to seventy feet after reaching the bunker, pass it through the door, and presumably lifting it up again and piling it up in the bunker. There is no doubt about it that that system, obviously, on the face of it, is impossible for coaling ship. It could only be made possible by fitting twenty-five or twenty of Mr. Dickie's outboard gears to a similar number of fixed trunks, a thing which has not been found possible in the system which we had to give up a few years ago. That was a fatal objection to Mr. Dickie's system. The reduction which he uses in the number of trunks would be utterly impossible—the amount of trimming in bunkers which would be required of it. I am afraid that Mr. Dickie has also allowed his optimism to get the better of him in this case, because I can assure him if such a system was fitted on board ship it would never be used but once.

COMMANDER W. HOVGAARD: Mr. President, I think all naval architects will sympathize with Mr. Dickie in his efforts to simplify the construction and outfit of war ships. Naval constructors in all countries have to struggle against the great number of claims to improvements and innovations largely forced upon them by other branches of the service, claims which arise as a

natural consequence of the rapid technical development. The naval constructor has to determine to what extent such claims can be fulfilled without undue detriment to the other interests, and notably without sacrificing fundamental principles of design. Every proposal should be tested by examining whether or not we depart from such principles in carrying it out. The principle which is most important, first of all, to bear in mind in ship design, is that of the safety of the ship. I propose to review some of the important modifications proposed by Mr. Dickie in the light of this principle of safety.

First of all, the central passage is not a new feature. It is already introduced both in this and in at least one other navy. What is new in Mr. Dickie's proposal is that he has carried the central passage nearly to the ends of the ship, and that for part of its length it is placed very close to the inner bottom. While it is true that the midship portion of the central passage has an almost perfectly protected location, this is far from being the case near the ends, notably forward, where the passage is liable to damage by grounding, torpedo explosions and ramming. What happens if a serious leak is produced in the central passage? In a very short space of time it will be flooded from end to end, for there are no water-tight doors in the passage; the drainage and ventilating systems will at once be paralyzed, the central commanding station will be put out of action, and, worse than this, the numerous ventilating trunks that lead from the central passage out to the ship are likely to act as so many ducts for the water, and the water will pour into all the important compartments of the ship and the engine room. This danger could, of course, be largely obviated by automatic valves, but whether they will really act in time of emergency I suppose is somewhat doubtful. On the whole, the advantages by the proposed extension of the passage do not seem to me to outweigh the increased risk.

As to drainage, the system proposed by Mr. Dickie embodies two steps in departing from the present. First, the drain is placed in the double bottom; secondly, it is built into the ship, so that one of the containing walls of the drain is part of the outer shell. That is not a new step; that is, on the contrary, a retrogression to former installations used in the English navy, and I believe also in this navy, and still used in the French navy, where the main drain pipe is placed in the double bottom, suspended in the inner bottom. The other step that he proposes is, instead of a drain pipe, to build the drain into the ship, into the double bottom itself, so that one of the containing walls is the outer bottom or keel plate of the ship. Here, of course, there is a very serious danger of damage, and I think, besides what Mr. Taylor pointed out, there is a probability that in case of grounding, not only the drain duct may be damaged itself, but also one of the large compartments, say one of the boiler rooms, and no one will know whether the drain duct is damaged or not. What happens is this: that the man in the central passage will open the drain valve to the boiler room in order to begin to pump out, and then the water will flow from the sea into the pumps, and it will flow from the sea into the flooded compartment, and it may not always be easy to see from where the water comes. I think that is a very serious danger.

I think on the whole that the system adopted by the French, where they use, beside the circulating pipes, powerful centrifugal pumps at the end of the main drain, is very advantageous. I think there is some objection to having all the pumping power, so to speak, at one end of the main drain, and I think also that Mr. Dickie is right in his criticism that to use steam pumps and fire pumps for drainage purposes is not desirable. After all, pumps of a capacity of fifty tons per hour, or, as in the English service, one hundred tons per hour, are very small compared with the capacity of the circulating pump which goes to several thousand tons per hour. Therefore, I think that if pumps shall be connected to the main drain besides the circulating pumps, they ought to be very powerful pumps, at least some 500 tons per hour. That is done in the French service, for instance in the *Suffren*, battleship, where the main drain is provided with four such centrifugal pumps of 1,000 tons per hour each, and is besides connected with the circulating pump of the central engine.

As to ventilation, Mr. Taylor has already spoken so fully on that that I shall not say anything more about it, except that I think that one feature is very undesirable in his proposal; that is, that the armor deck has to be pierced in so many places with his system.

The system of boats, and stowage, and handling of boats proposed by Mr. Dickie, I think is likely to be quite heavy and cumbersome, and I think that something lighter and more simple must be devised than the English system, where they use the mast, and they have large booms, one on the main mast, and generally two on the fore mast, and they have each of them a couple of windlasses. These booms are also used for the coal handling. Each of the booms can carry a Temperley transporter in large ships, some 55 feet long, and I think that is the simplest and readiest system that can be devised for boat handling.

As to the reintroduction of Scotch boilers, I will only mention that the latest reports from the war in the east point to the fact that the cylindrical boilers have consantly given trouble. The ships of the Japanese navy with cylindrical boilers have had to go quite frequently into port, whereas all the ships fitted with Belleville boilers have given no trouble whatever. The Russian cruiser *Pallada* was struck by a torpedo right inside one of her groups of Belleville generators, whereby the tubes were torn out and bent S-shape. The tubes were taken out, straightened and replaced, mostly by the ship's own engineers.

I think we must all be grateful to Mr. Dickie for bringing these important questions up for discussion. No time could be more opportune for it than the present, and although I do not agree with the author of the paper in all his proposals, I certainly agree with him in a general way in his endeavor to simplify the design of war ships.

Mr. F. D. Herbert: In looking over this paper I have been much impressed with the simplicity suggested in new design. There is one feature, however, I would like to be informed on, and that is how the central passage is entered through the protective deck. The long, central passage is inaccessible except at the very forward end, so far as I can judge from the paper.

MR. TAYLOR: It is stated in the paper on page 4, "Between frames 11 and 12 a vertical trunk 3 feet by 2 feet 6 inches, having an air lock entrance from the gun deck, affords means of access to the central passage."

MR. HERBERT: It appears to me that it is not practical, if the only method of gaining access to this passage is at one end of the ship.

MR. J. R ANDREWS: I would not presume to discuss many of these points with men of Mr. Dickie's ability, but on pages 14 and 15, regarding the steering gear and windlasses, he states that the windlass can just as well be operated electrically as a boat crane. Now, I think Mr. Dickie has lost sight of the fact that with a boat crane the maximum load is constant, while in the case of a windlass the maximum load is limited only by the breaking strength of the chain. Now, the two conditions are entirely different to my mind. I think that possibly the time may come very soon when electrical power can be used for operating steering gear and windlass gear. I think as regards steering gear the time has practically arrived. We have furnished a steering gear for one important ship, which was made on the Brown patent, with electric motors for driving, which I understand has been very satisfactory. On this particular ship there is no auxiliary steam gear attached, and so far as I know there has been no trouble with the electrical gear.

On the windlass question, I think that the Navy Department would welcome the time when the electric question can be solved satisfactorily as regards the windlass, and it certainly overcomes some very serious objections in the matter of running steam pipes. But up to the present time I do not consider that it is safe to discard the steam power for that particular machine. I should like very much to get the views of others on this point, because it is something that I am especially interested in.

MR. KELLOGG: I have had some talks in years past with Mr. Andrews on the subject of electricity for the windlass. We have always felt that the most desirable point to start an electrical plant on shipboard is practically the steering gear windlass. Those have been left for the last, principally, I believe, because they require a great deal of power and the central station has not been of sufficient capacity to take care of these in emergencies. But I think that all naval ships now have the power, and it should be used for either or both of those purposes at any time, and the question of having power can be taken care of in electrical appliances just as well as it can be in a steam appliance, and we stand ready at any time to furnish apparatus. I represent the General Electric Company. We stand ready to furnish apparatus that will take care of this particular appliance.

Mr. Dickie takes up the question of the power in the central plant. I do not feel that he has allowed anywhere near enough power for operating the appliances on shipboard. He has not allowed nearly enough for the ammunition hoists. I think that the power that he gives there would be required by those alone without any other appliances. He has not made any allowance for those or for air compressors, which I think are required now, or torpedo tubes. He has made no allowance that I can see for any form of operating gear for his torpedoes. The requirements of the plants have usually been larger than was contemplated at the time everything would be fully loaded. I do not think there is any great difference between a motor standing still or operating. Probably it would be in a little better condition if it were operating all the time than if it was standing still a good portion of the time. I have been for a long time advocating much simpler methods of installation of the electric wires on shipboard. It seems to me that we are using altogether too much pipe to lead conductors. There was one plant, on the *Kearsarge* and *Kentucky,* that was put in with the main leads simply insulated with ordinary methods or with heavy windings of jute and cord on the outside—braid—and lead in insulators all exposed along the wing passages. I have never heard of any trouble with those conductors, and the installation as a whole is very much lighter and is fully as reliable as any that has been made since in this particular. To-day the tendency is to lead everything in the pipes. I think that in all mains this could be done away with without any detriment to the ship.

MR. ANDREWS: I should be very glad if Mr. Kellogg would tell us a little more definitely just how he would arrange these things so that it would be perfectly safe to use electricity for purposes where the maximum load is not absolutely fixed, as in the case of a boat crane, or an ordinary winch. With windlass or boat cranes I should never consider using anything but electric power with the drive; but we furnished some capstans for the Russian battleship and cruiser built at Cramps' some time ago, and the great difficulty which was found there was not the fact that there was not sufficient power to drive them; the electrical appliances worked perfectly so far as they went, the capstans worked perfectly; but the trouble was when they got a line on the dock hauling the ship, the operator or the man who was handling the line could not feel his load. The result was that when he got a strain suddenly the motor simply kept going and parted the line. The same thing applies in the windlass. I think it is the earnest desire of the Navy Department to use electric power for this purpose, but up to the present time no sufficient guarantee has ever been given that anybody would build the electrical end to meet the exact situation which has got to be met in this case. I can say further that if anybody can meet this condition we shall be very glad to purchase something of the kind and put it in.

MR. KELLOGG: I can very quickly tell one method which could be used. The cylinders on the engines that would be used for the windlass might be the same proportion as the cylinders of the engine driving the generator. Therefore you could not very well overload the windlass without slowing down the engine. For the purpose of experiment in connection with one merchant ship, we used the electric machine driving that way and connected to the motor, and absolutely stalled the motor and had it respond absolutely with the load it was raising and lowering. The current used was not so great as to endanger the motor or the generator at all. Another way, which is the same we have applied recently in connection with a motor for a water-

tight door, is to make a high resistance either in the armature or circuit which will limit the flow of the current—not have any circuit breakers or anything of that kind in it. Then the response is immediate; if the load is released it takes up exactly the same as a steam engine. As it is brought on the motor can be stalled without any injury to itself or to any of the apparatus.

Mr. J. G. Winship: I notice an item in Mr. Dickie's paper on feed-water heaters. I do not think that the experience of the user of feed-water heaters in modern vessels would back up Mr. Dickie's opinion. It seems to be the idea now, in most all of the merchant service anyway, that the feed-water heater is a very necessary connection with running steam engines. I refer to the remarks on page 18. I have found that the advantage of a feed-water heater in connection with marine engines is that you can keep the temperature of the feed-water up to over 200 degrees, thereby keeping the boiler tighter, as they say; and another thing, you can carry higher vacuum on the engine and get better results all around by the use of the feed-water heater. As to the kind of a feed-water heater—that is another thing.

Mr. J. C. Kafer: There are many things mentioned in this paper that might be changed. But there is one thing that has not been mentioned. I think in a naval vessel, if they threw off every bath tub in the ship they would save a lot of space for other purposes. I have been at sea, and scraped off pretty clean after being dirty, without a bath, just with four tin boxes put together, and you can take a bath in that way just as well as in a bath tub. That is a very importnt item which I think ought to be brought forward.

Mr. Ferguson: Mr. President, I think the last speaker has brought up an idea which is really at the root of the simplification of war ship design. The proper way of simplifying a war ship is to simplify the requirements. If you are going to have long-arm doors, or doors operated from a distance, it really does not make very much difference whether you use Mr. Dickie's system or any other system; it is going to be complicated. If you do what can be done under some of the most recent designs, if you could leave out the doors altogether, you have a better ship, both so far as simplicity and safety are concerned. Mr. Dickie has simplified very much by doing away with the requirements of people who design ships, which was brought out very strongly by Captain Hovgaard; that is, he has simplified by virtually destroying his transverse watertight subdivision, which is probably the most important feature in a ship after the general requirements are once set and the characteristics determined. He has done away with it absolutely; even ventilation and other systems are to work with the valves open, and we all know that a valve or a hole in a bulkhead is generally, after years of service, equivalent to a hole without the method of closing it; that the only way to make a bulkhead tight is not to put a hole in it. Now, the idea, as I understand it, of the present system of ventilation is to ventilate a compartment from the top, which is, so far as the safety of the ship is concerned, the only way to do it, because otherwise you must have valves which are open, or automatic valves which do not work.

I think in regard to his boat stowage and handling scheme and drainage, he is doing what is done by most simplifiers of war ship design; he is proposing to substitute a scheme of his own for some one else's scheme, and that is what simplification generally reduces itself to by most people who propose it. Boat stowage could be simplified enormously by leaving off a great number of boats, which is done actually in time of war, and which will probably be done to meet the requirements of new arrangement of batteries sometime.

The electric power he has, as Mr. Kellogg pointed out, increased considerably, at the same time reducing his main generating plant. Either he has no margin or has not allowed enough power. In the case of the turret turning motors and ammunition hoist motors, the power that he has allowed is entirely inadequate.

As to leaving out voice pipes and omitting other fittings, I think that he has the sympathy of every one who has to deal with these things. But I am firmly convinced that the proper way to really simplify is to simplify the requirements, not only of the people who go to sea, but of the people who build and design ships. If they do not take some chances ships are going to be complicated, and war ships are going to be extremely complicated. It is just a question of putting in one man's device instead of another's.

THE SEMI-GLOBULAR NAVAL BATTERY.

by Anson Phelps Stokes, Esq., Associate Member.

ABSTRACT.

This paper is a description of a new type of floating battery patented by the author, and somewhat similar to other designs of floating battery. The plans call for a semi-globular vessel, 180 feet in diameter, 36 feet draft, and 24,650 tons displacement. The hull is built of steel throughout and the sides are heavily armored. The thickest armor is at the water line, 24 inches maximum, while the top sides are 15 inches, and the turrets the same thickness. The bottom of the hull is supplied with 1-inch armor. The armament consists of six 12-inch guns mounted in pairs in turrets; two 15-inch guns; eight 6-inch guns, besides smaller rapid-fire guns which, it must be admitted, is a light battery for so great a displacement.

The hull is subdivided by decks and bulkheads into a great number of water-tight compartments, while the entire superstructure is separated into three equal segments by three radial bulkheads. Each one of these has its own boilers and machinery, with the idea of making each independent of the other in case of accident. There are in all four engines, one in each of the forward segments and two in the after segment. Calculations and drawings have been carried out in considerable detail, and it is claimed by the author that such a floating battery is practically impregnable, and is indispensable in successful defence of our coast ports and of the Caribbean sea, now such a strategic point owing to the building of the Panama canal.

DISCUSSION.

Commander W. Hovgaard: Some thirty years ago, or perhaps more, that same proposition was made in Denmark. It was then proposed to build what were called floating forts—essentially the same as this—to be

used for the defense of Copenhagen. The matter was very carefully gone into at that time by the Danish government, and, after consideration, it was found preferable to build a fort on shore, and the front of Copenhagen being very extensive it was found necessary even to construct a small island on the shoal outside of Copenhagen, in 24 feet of water, on which a fort was built which is there now, and armed with, I believe, 14-inch guns, a very powerful battery. That fort cost altogether a little over two millions of dollars, and carried a great number of 14-inch guns, and, of course, a secondary battery besides.

The reason why the Danish government adopted that course, and did not go in for the floating batteries, I think, was the same that had made the Russians abandon the *Poprovsk,* namely, that such batteries, of course, however strongly you armor them and however carefully you subdivide them, are always ultimately liable to destruction by torpedoes and mines—possibly by ramming. Moreover, it was found that the *Poprovsk* steered very badly. Going up stream it would steer very fairly well. Going down stream it would be entirely unmanageable. Also, the propulsive coefficient being very low, it was impossible to obtain any considerable speed without a very undue expenditure of power. The great size, I am afraid, will cause difficulty in itself, because you must have docks to take the ships into, and I think that would be a very serious problem, to construct docks with nearly 200 feet gate entrance and 30 feet depth. They would, at any rate, be exceedingly expensive.

Turning the guns by turning the whole ship I think is likely to prove very unsatisfactory, in a ship that is so unmanageable as a circular ship is bound to be. The slightest lack of symmetry in the propulsive forces will send the ship turning round and round, and with the tremendous moment of inertia it is likely that it will be extremely difficult to stop her again—at least at any desired point.

COLONEL EDWIN A. STEVENS: Mr. President, it is rather curious that the first reported experiments against armor were made with the view of determining the availability of a battery very much similar to this one, during the war of 1812. Of course the thing was a very crude idea compared with Mr. Stokes' suggestion. The battery, of course, never was built—I don't know whether it even progressed as far as the design. She was to be anchored similarly to this one from the center, either by a mushroom anchor or by a spud, and was to rotate by screws, and fire her guns as they came around.

The same objection that Captain Hovgaard has raised as to the training of the guns on account of the instability of steering was raised during the war to the gunboat *Naugatuck,* which carried a 100-pound Parrot rifle absolutely fixed. The objection made by all naval officers was that it was absolutely impossible to hit anything with her. As a matter of fact, she turned out to be the most accurate shooting boat in the United States navy at the time.

I have always had a fancy for floating batteries. Small, ironclad vessels were used, I think, at the siege of Gibraltar, in 1804 or 1807. They were certainly also used by the French in the Crimean war. It would, of course, be impossible to drive any such design as this at any high speed, but it does seem that when we have just sacrificed speed so that a vessel cannot manœuvre in squadron, it cannot run away or overtake other vessels, it makes very little difference whether you have a little more speed or not. In other words, if we compare the usefulness of a design of this kind with the usefulness of our monitors, we have got a collection of vessels of that type which cannot run away from anything nor catch anything that merits the name of a war ship, and that cost money, and which, I believe, will generally be conceded are not a match for any vessel carrying anything like their main battery. The question is whether a floating fort, impregnable so far as artillery is concerned, would not be a better investment of our money than we have in the monitors.

THE SEA-GOING BATTLESHIP.

BY COMMANDER WILLIAM HOVGAARD, ROYAL DANISH NAVY, MEMBER.

ABSTRACT.

This paper is probably the most comprehensive treatise of a battleship that has ever been published, and embodies the design of a type of sea-going battleship to meet the present-day requirements. The fundamental elements of design, speed, armament, and radius of action are shown to depend on the work which the ship has to do. These elements being chosen, it is shown how the other elements—nautical qualities and protection—follow as a logical consequence. When considered from this point of view, the type of battleship will not suffer the variations in the building programme of successive administrations, but will indicate the true direction in which progress must follow. In this treatise the author is guided largely by the experience of the Russo-Japanese war and by the average conditions which the battleship must be prepared to encounter. The value of the claims of seaworthiness, armament, protection, speed, and endurance must be based upon the success with which they are worked into a harmonious design. By analyzing the present conditions, the author is able to make several deductions for his type of ship, and, at the end, he evolves a design somewhat similar to the *Connecticut* and *King Edward* classes. He states that while modifications proposed are of great importance, yet they are stepwise in character, and follow as a natural consequence of recent changes in the means and methods of war. The principal points are:

"Complete substitution of semi-heavy guns for the quick firers of secondary batteries, and consequent installation of all secondary guns in turrets, preferably twin turrets, placed on main deck. Greater subdivision of engine power by triple screws. Use of oil fuel by mixed combustion. Greater metacentric height and hence somewhat greater beam. Abandonment of center line bulkhead except where necessary between engine rooms. Both inner bottom and wing passage bulkhead to be fitted along the sides. Greater distance of lateral bulkheads from side. Wing spaces arranged as compensating tanks for righting the ship. Side armor to maintain midship thickness and height to extreme end of magazines, where the transverse armor

bulkheads should be placed. Lighter protection of barbettes below main deck. Only one armor deck.

"We have arrived at the proposed type on basis of specified conditions. It has been shown how the qualities required to meet these conditions are interdependent, and how, therefore, only one solution can be the best, namely, that which is consistent with the organic relations existing between the different elements of the design. In the battleship so designed we may say that the qualities are harmoniously balanced, since no one is unduly favored at the expense of the others, and each is present in a sufficient measure. This solution has necessitated a displacement equal to that of the largest battleship now building. As shown in the paper, this is due to the fact that the large ship, apart from its superiority due to higher speed, greater gun power, and better protection, is inherently superior to the smaller in point of nautical qualities, water-tight subdivision, economy of propulsion, and relative sea speed. These qualities cannot be attained in the same measure in a smaller ship, and, since they are not subject to addition, they cannot be compensated for by a greater number of units. The deficiencies will be greater the smaller the ship."

As a result of recent developments, the author admits that the use of sea-going battleships is limited and that there is an increased necessity for the construction of special artillery vessels for coast war.

DISCUSSION.

Mr. Forbes: I would like to ask the captain a question. On page 21 he says: "We may reckon the relative importance of the guns to be proportional to their penetrative power." In all battleships the chase of the turret guns is very much exposed. I would like to ask the captain if the fact of the area being so small is its great protection?

Commander Hovgaard: No. I simply argue that the protection should be proportional to the importance of the guns, and I measure the importance of the guns by the penetrative power and by the arc of fire of the guns. Now, the arc of fire of the broadside turret guns must be considerably less than that of the heavy guns placed at the ends. They have 270 degrees of arc of fire, while those of the port side would hardly be able to get more than 180 as a maximum. Therefore, taking that as a consideration, I argue that the greater rapidity of fire of the smaller guns is balanced by the smaller arc of fire, and therefore on the whole that the importance of the guns becomes proportionally higher with their penetrative power, and therefore they should be protected on the basis of their penetrative power simply. I have not considered the other question of the protection of the chase of the gun.

Mr. Forbes: Another thing is the location of the conning tower. There is nothing said about that in this paper, but I notice it must be very heavily protected. I saw particularly a ship not long ago where the conning tower is so placed that to me—not being a practical nautical man—it seemed impossible to manage the ship under any condition, unless you are fighting head on. It seems to me that if the conning tower is as heavy as the captain suggests, it would be put above everything, and should be so placed.

Commander Hovgaard: As regards the location of the conning tower, I have not thought to suggest any other location of the conning tower than is usual in the modern battleship. I think it is almost impossible to make any change in that.

Naval Constructor Joseph H. Linnard: Although I have not had an opportunity to examine this paper in advance of the meeting, it appears to be a very carefully considered and compendious statement of the problems that are involved in the design of a battleship. We have had a paper showing the desirability of simplifying ships, particularly men-of-war, and this presents to us some of the reasons why complications are necessarily involved to obtain the requirements that modern conditions of sea warfare demand, and the paper states so clearly the various conditions that must be set off, the one against the other, and the different reasons which lead to balancing one quality against another, that it seems difficult to make any remarks that would not be more or less a reiteration of the statements in the paper. But it is one that certainly will lead any of us to give more thought to the problems that are placed before us in these questions stated.

Rear-Admiral George W. Melville: Mr. President, I am very much pleased to see that our society is honored with a paper from Captain Hovgaard in regard to designs of battleships. I am pleased to say that I see nothing at all in it to condemn, much to commend, and very little to criticise. Among other things I am pleased to say, as ex-engineer-in-chief of the navy, among the hard hitters of the triple-screw system of battleships, that I at least have his backing on the subject.

The President: Are there any further remarks? If not, the chair feels justified in saying that this paper will bear undoubtedly thorough and careful study, and it must be gratifying to every one who has been engaged in the design of war vessels to have such a thorough and logical treatment of the subject as this, producing results which to a very slight extent modify the prevailing types. There are no doubt points of gratification in this paper to our vice-president, Admiral Melville, and there are undoubtedly to others. One especially satisfactory to me is the fact that the second armor deck, a feature of the British navy, has been omitted, and it may be right to remark that the omission of the second armor deck in our battleships has been the most important means of giving us an advantage in offensive power.

SECOND SESSION.

The second session was called to order on Thursday afternoon at 2:20 with the president in the chair.

SOME RECENT EXPERIMENTS AT THE U. S. MODEL BASIN.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N., MEMBER OF COUNCIL.

ABSTRACT.

This paper gives the result of experiments which have been carried on at the United States experimental model basin for determining the power and efficiency of model propellers of the ordinary three-blade type, throughout the range of pitch ratio and blade area

regularly to be encountered in practice. The experiments covered thirty model propellers varying from the low pitch ratio of .4 to 1.5, and for each pitch five propellers with different widths of blade were used. As a result of these experiments a new propeller formula has been evolved.

Where S is a power coefficient derived from the author's experiments, P denotes the horse power absorbed by the propeller, d the diameter in feet, and V the speed of advance of the propeller in knots.

Then, $P = .0093648\ Sd^2\ V^3$.

The probable effect that the back surface of the blade has upon the true pitch is indicated in the propellers of narrow blades. The most unusual feature of the results is the disclosure of the fact that as the pitch ratio is decreased the influence of the area of blade upon the results also decreases until for propellers of very fine pitch the narrow blades actually absorb greater power. It is also shown that the maximum efficiency of a propeller may reach as high as 79 per cent., which is about 10 per cent. higher than formerly believed possible. Accompanying the paper are several figures illustrating the form of blades used and plotting the results of the trials. It is, indeed, one of the most valuable contributions on propeller data that have been contributed, and ranks on a par with Froude's and Durand's experiments.

DISCUSSION.

COMMANDER WILLIAM HOVGAARD: I think the society must be very grateful for the extremely valuable information which has been given to the transactions through this paper.

Mr. Taylor remarks that the efficiency falls off very much at the lower pitch ratios. That is, in fact, seen from the curves. I think that is a fact which has great interest with turbine propulsion. The fact is that the turbines have their greatest efficiency at a very high speed, and very high speed of revolutions means always a low pitch, a feature of which becomes greater the lower the speed is. It is mainly desirable to work with a certain slip, or at least not to fall below a certain minimum slip. Therefore, if the number of revolutions is high the pitch must be small. On the other hand, also, the diameter is limited with regard to cavitation. We cannot go below a certain area of the propellers, and therefore we have to do one of two things: either we have to split up the power in a great number of propellers, as is done in some ships, and that is undesirable and has proved to be not very efficient; or else we have to accept a very low pitch ratio, which we have now seen is also inefficient; and therefore since this objection is greater the lower the speed is, it seems that there must for every type of turbine be a certain speed below which it does not pay to use the turbine instead of the reciprocating engine. I think it is an understood fact that we must expect for every type of turbine to limit it to the speed at which it will be advantageous to use the turbine as a means of propulsion. This fact was pointed out by Prof Latrobe last spring, at the meeting of the Institution of Naval Architects in London, but it is corroborated here by the experiments which Mr. Taylor has laid before us.

COLONEL EDWIN A. STEVENS: It is of course impossible to digest the matter submitted by Constructor Taylor in this paper in even a period of many days—certainly not in the time this paper has been in my hands. I am only struck with the immensity of the ground he has covered, and at the fact that he has been able to accomplish what he has done at all. When we consider the ground covered by the experiments—the fact that Froude's, really the classical experiments, included practically three-bladed propellers and any one series of two and four blades, and in those the only variable was the pitch, and that Prof. Durand's experiments included a blade of constant pitch but variable in area—and when we consider that Mr. Taylor has varied both the area and the pitch in his experiments, the amount of ground covered becomes very evident, and that great care must be necessary in summarizing the results is also very evident.

I have recently had occasion to want to determine, pretty accurately, the performance of propellers, and in employing different formulæ to check the work I came across a result similar to the one given by Mr. Taylor; that is to say, that under the conditions existing in that case, not only the thrust but the power absorbed by a wider blade would theoretically appear to be less than with a narrow blade. Mr. Taylor makes it less on slip in this case. I am plotting on the area of the blade. It would appear to be theoretically indicated that such is the case. Practically in my experience I have had a similar case, but it arose in a full-sized vessel and without the accurate measurements which were necessary to determine such data with scientific accuracy, I could only give it as a general tendency. In that case there was the four-bladed propeller not working as efficiently as was hoped for. It was thought then that a better solution might be reached by substituting three blades of practically the same helicoidal surface as the original four blades, trying the propeller under these conditions. This was done, and the power absorbed by the larger three blades was practically the same and the thrust slightly less than with the four blades.

I see that in the appendix Constructor Taylor has gone back to his formula and substituted for the $S\ V^3$ which he expresses to-day, making the formulæ practically the same, excepting that S is drawn from curve instead of being drawn by calculation from the outline of the wheel. I have used that formula, and generally with good results. It has always seemed to me that the sensible way of getting at a propeller was that, as soon as the first elements of your ship were fixed, you had a general idea of your displacement, a general idea of the power necessary to attain the desired speed, you should begin at the other end, determine the resistance of your ship and the thrust necessary to overcome that resistance, and then design your propeller to give that thrust, and simply rest your design on that, of course with such modifications as are always coming in, in tentative first arrangements. In other words, it seems to me we more often run into trouble with our propellers from insufficient allowances, from diameter or for speed in revolution, than we do with almost any other one single item of design, and that it is a point at which the economy can be secured with less expenditure than almost any other. In other words, we make a mistake

in our propeller and then try to remedy it in very costly arrangements with the engines or with an expensive inefficient plant.

Naval Constructor Joseph H. Linnard: Mr. President, I have had the pleasure of seeing a few of the runs made in the model basin with these propellers, and one of the reasons that I went down to see them was that I wanted to get what cavitation looks like when you have it, for we have heard a great deal in recent years about cavitation and the disastrous effects it produces on efficiency of propulsion. I had had rather the impression that when cavitation occurred the water was sucked down from the surface to a certain extent, owing to the lack of pressure at the back of the blades. But in actually running a propeller in the model basin that is cavitating nothing of the sort occurs. The water in the basin is very clear, and you can see the propeller perfectly well until the speed of rotation becomes so high that it turns into a disc. But when running at ordinary speed, at which the cavitation does not occur, you can see this bronze rotating with the light reflected from the blades, and the water remains perfectly clear and the surface of the water in the basin is practically undisturbed over the propeller.

As the speed increases the propeller develops gradually a slight haze behind it. The water, instead of being perfectly clear as before, becomes slightly clouded, and as the speed goes up higher it becomes noticeably clouded, and the propeller itself is followed by a long cylinder of cloudy water which has precisely the same appearance as if there was a sight infusion of milk following the blade. It apparently is practically cylindrical. The facilities were not such that we could look at the front of the blades. But at the same time, when this cloudy appearance occurred, the water still remained on the surface as absolutely undisturbed as it was before, and apparently the surface disturbance was *nil,* although the appearance associated with cavitation and as shown at the front curves was in strong evidence. The interesting thing to me is how this cloudiness appeared, and there would seem to be only one explanation for it; that is to say, on the theory that Mr. Taylor announces that the cavitation is due to the parting of the water and its failure to immediately close, creating a vacuum. The contained gases in the water are liberated to a certain extent and flow behind with the blade, producing a sort of gaseous condition, like air being released in the water and not immediately absorbed again, and this appearance seems to confirm Mr. Taylor's opinion of the real cause of cavitation. Mr. Taylor tells me that he hopes to go on with the experiments with four-bladed propellers, and until he has done so he does not desire to announce any general theory; but, like all experimenters that go into their work without prejudice, he tells me that some of his preconceived theories, which he has already announced, have been very rudely disturbed, and I hope, therefore, that at a future date he will be able to give us a more thorough discussion of the general aspect of the question as disclosed by the experiments and treated with the mathematical ability which we all know he possesses.

One thing that struck me as the experiments went on is particularly disclosed in reference to those propellers No. 23 and 23A and B, and that is the influence of the back of the blades. It would seem that most of us in considering propellers give all our attention to the driving surface of the blade, with the idea that that is doing the work and the back of the blade is rather left to take care of itself. When we determine the thicknesses from experiment and theory that we think are necessary to give the necessary resistance to the blade so that it will stand up to its work, that is all that is necessary, and the general shape of the back of the blade seems to take care of itself to a great extent with those limitations. But these experiments seem clearly to indicate that in designing it will be as necessary to consider carefully the shape of the back of the blade as the shape of the front of it.

The President: Are there any further remarks upon this paper? If not I will ask Mr. Taylor to make such remarks in reply as he desires. While it may not be desirable to press him to give us an outline of his further work that he has in mind, I have no doubt it will be interesting.

Naval Constructor D. W. Taylor: Mr. President and Gentlemen: With reference to Commander Hovgaard's remarks, Commander Hovgaard pointed out very truly that these experiments show a falling off in efficiency as the pitch ratio is decreased. I might point out, however, that that is associated with propellers which are all of the conventional shape of blades, a helicoidal driving face and a convex back, practically the arc of a circle. I am inclined to think that some of this falling off in efficiency could be prevented as the pitch is decreased by suitably modifying the shape of the back of the blade. The experiments with 23A and 23B indicate that something could be done along that line, and I hope to make further experiments before long with four-bladed propellers, and in the series I expect to introduce a few modifications in that direction to test what could be done.

Mr. Forbes: Do you mean flattening or increasing the arc?

Naval Constructor Taylor: I would anticipate that if I flattened it we would get better results. Propeller 23B, which shows low efficiency, was a very extreme change; but you will note that at the low slips the efficiency was higher than the others, and I expect that if the change had been such that it was accommodated to a 15 or 20 per cent. slip, the efficiency could have been brought back to fully what the other shows, retaining the very desirable feature of high value of S coefficient. This high value of S coefficient, as I pointed out before, enables the propeller to be made smaller, which is necessary when the pitch is small, as it must be with quick running engines, to keep the diameter down as small as possible. I think, perhaps, that with a man-of-war there may be something gained with the quick running propellers by making them four-bladed instead of three-bladed, but that is a matter that can really be settled only by experiment.

Relative to Colonel Stevens' remarks, I might say I point out in the paper that the first regular test of a model propeller was made in August last. Of course we had been preparing apparatus for some time and making tests in order to get the experimenters drilled,

so that we could finish them rapidly. We cannot give very much time to this work; it is something of a side issue for the model basin, and it was necessary after we got propellers made to get rid of them as soon as possible. When we were well under way we ran two model propellers a day, one in the morning and one in the afternoon, completing the experiments. We generally ran at 4, 5, 6, and 7 knots' speed of advance of the carriage, and at each speed of advance of the carriage would make 6 to 8 runs of the propeller at various slips so as to cover the range. The fact that Colonel Stevens has brought out with regard to actual full-sized propellers is very interesting, and confirms to some extent the results reached with the experiments with the models. As I point out, it is necessary to be cautious, and not to apply these results to full-size propellers until they are actually confirmed by experiment. But that is very difficult, and every piece of evidence which indirectly confirms the accuracy of the model results as applying to a full-sized propeller is of value.

I might add to Mr. Linnard's statements about the cavitation—he brought out the fact that the water was undisurbed. But it is mentioned in the paper that the propellers were placed their own diameter below the water. The center of the propeller in each case was sixteen inches below the surface for the regular runs. The run on which he saw cavitation was made while the basin was being filled up after it had been pumped out a little, and I think at that time there were only about 4 inches of water over the top of the blades, only half of what was present during the ordinary run. It may have been even less than four inches; but even at that speed there was no disturbance at the surface of the water immediately over the propeller and for several feet behind it.

The President: I would suggest, Mr. Taylor, that if you have in mind any comparisons between model propellers and actual propellers, that the general subject of such comparisons might be outlined with a view to assisting in obtaining such results.

Naval Constructor Taylor: I do not think, Mr. President, that I am prepared to outline that at this time, because the problem is very much complicated as regards a full-size ship by the question of wake and thrust friction. The propeller attached to a ship, instead of working in undisturbed water, is working in water which is very seriously disturbed, and it is not only driving the ship ahead, but it is sucking up water, and that introduced a number of complications which will make it quite a serious undertaking. If we knew in the case of a full-sized ship the exact wake and the exact thrust friction, why then we could try various full-sized propellers, and determine the speed and have the results analyzed, trying also the models of those propellers. We have under design apparatus for investigating the wake of the models, and I hope in a few months more to be able to determine that wake with fair accuracy as regards the models.

There will be necessarily some slight uncertainty as to whether the wake of the model is exactly the same as that of the ship; that is, with 10 per cent. wake of model whether the ship will also show a 10 per cent. wake. But there is one thing in these trial results, and which is very obvious from watching the run of the models, that this wake for a given ship is not a constant. It is generally assumed to be constant for the purpose of design, but if you watch the model under way you will see that above the propeller at one time there is a wave crest, and at another time there is a wave hollow, and it is a physical impossibility but that when the wave crest is there the wake is necessarily greater than when the hollow is there. The part of the wake due to the frictional drag of the vessel dragging the water along with it is probably not seriously affected by the speed. But the part of the wake which is due to the wave action is undoubtedly affected by the speed, and I think you will find in Mr. Powell's paper, which will be read to-morrow, analyzing the curve of efficiency of propulsion, the variation in that efficiency, which I ascribe primarily to variation of wake, we have found in analyzing progressive trial results a similar tendency in nearly every case. It generally occurs at the speed of ships corresponding to a speed of model a little under 4 knots. It appears that at that speed there would be a tendency for the wake to decrease. As you increase the speed the wake appears to gather strength again.

The President: Gentlemen, in suggesting a vote of thanks to the distinguished author of this paper, the chair probably voices your sentiments in saying that it has no knowledge of any more valuable or useful paper ever having been brought before us, and also may remind you that these results, presented in such an apparently simple manner, are the result of some years of study which has proceeded continuously, but, as Mr. Taylor says, as a side issue of this more important work at the government experimental tank.

In the absence of the author the next paper was read by Mr. Cox.

SOME FURTHER NOTES ON THE PERFORMANCE OF THE TORPEDO VESSELS OF THE UNITED STATES NAVY AT SEA.

by Lieut. L. H. Chandler, U. S. N., Associate.

ABSTRACT.

This paper is a supplement to one presented by the author before the society at its last meeting, and contains the data obtained from the flotilla of torpedo boats which crossed the ocean to the Philippines and those which have seen sea service along our coasts. The author states that while the greatest rolling recorded was 35 degrees, on the *Decatur,* in moderate weather, there is no accumulated rolling, so to speak, and that there rarely are more than three or four heavy rolls together; none of the serious wallowing was noticed. Further the author states that there were but a dozen times in his two years' experience on this vessel in which it was too rough to set the dining room table. The rolling and pitching in the Asiatic flotilla never caused any serious trouble to machinery, although it was necessary to handle the engines carefully when in heavy weather. In criticising the type of vessels, the author suggests that future boats should have a less ratio of length to beam, even at the expense of speed in smooth water; that coamings 4 feet high should be about all important hatches; that the stern be

modified to decrease pounding and consequent shattering tendency of the hull. As the author has been conspicuously identified with the operation and manœuvring of United States torpedo boats, and has done much to bring this type into good repute, his remarks are of special value. The paper contains several tables of data of observations taken on torpedo vessels at sea, and there are several half-tones illustrating the close wedge formation when manœuvring.

DISCUSSION.

Commander William Hovgaard: In the fall of 1888 the Danish government fitted out three Thorneycroft, first-class torpedo boats, to compare their sea-going capabilities. One was very much stiffer than the others. The period of oscillation of the stiff boat was about 1 3-4 seconds for a single roll—consequently much stiffer than are the American destroyers. The other boats had a period of 2 1-4 to 2 1-2 seconds for a single roll. One of these last-named boats had a fin keel; the other boats had bilge keels. The fin keel was placed diametrically under the keel, and of a very large area, about 2 feet deep. The first of the boats tested was examined for a period of roll. The center of gravity and curves of stability were calculated; in fact, all that could be known about these boats was found out in the navy yard before they were sent out. In a cruise, that lasted about 3 weeks, we tried to get all the rough water and bad sea we could find in the Baltic and in the Categat.

We had battens for measuring the roll, and the rolling was measured systematically at different angles relative to the direction of the waves. We took it with the sea right ahead and four points on the bow, and so on throughout the whole circumference of the compass, and in that way we got a very complete series of results which we could compare, and it was found there that the boats of small stiffness would roll very badly. Sometimes when placed in a certain position to the sea, like the American boats here shown, they would take very excessive rolls at times; but it was curious that this was combined with a very small average medium roll, so that the boat that would take the greatest oscillation sometimes would be really the steadiest boat, the one that would have the smallest average of roll throughout the whole series of observations. The action of the fin keel, which was one of the most interesting points, was very marked, and that boat, which I happened to have command of, behaved decidedly much better than the others, and as found by Lieutenant Chandler, the worst rolling was generally experienced when the boats were going some three or four points from the wind. Then the action was strongest, and of course the momentum of the boat—the energy of the waves—was increased by the speed. We also found very considerable bending of the plates. We measured it up to 3-4 of an inch, even up to 1 inch, on one of the boats, but there was no sign of weakness. It was all within the limits of elasticity. The Thorneycroft boats had the same peculiar flat sterns, and they would pound badly at times, but not so as to cause any anxiety for the strength of the boats. The results of those experiments were published in the London *Engineer,* in 1888.

Mr. Weatherbee: Mr. Chandler has probably done more than any one man in this country for some time in bringing the torpedo boats into better repute, so far as their sea-going quality is concerned. For boats to steam in the wedge formation 15 knots, with the bow of one touching the stern of another, in even the smoothest sea, looks off hand to be quite an undertaking; but he has done it successfully in many cases. There are two things that strike one in looking over this paper. Referring to Tables 1 and 3, it will be noted that the sea-going displacements given in Table 3 are very much in excess of those given for the trial displacement. I figure that in the case of one of the boats this would be about 2 feet greater immersion than the water line on which she floated on trial. This would represent a freeboard of only 3 feet. Now, I think it is remarkable that a boat would go to sea with such a low freeboard as that and with such a heavy overload, and still be apparently seaworthy. This has also been demonstrated by the destroyers in the fleet that went out to Asia, and data of this kind are certainly reassuring, because torpedo boats have been spoken of as being of very light construction and not sufficient strength to stand any sea-going work.

Mr. Magoun: It might be interesting to have some further information on the performance of some of the other boats, but I don't know that anybody can give it. I know I cannot myself. But I should like to point out that the boats referred to in this paper have an entirely different form of stern from certain other boats of the navy, and I should think that the effects Mr. Chandler speaks of would be much more marked with the hollow stern than in some of the other boats.

The President: The absence of Lieutenant Chandler is certainly to be regretted, but it is gratifying to all those who took part in the design and construction of these boats that the evident verdict from the reading of this paper is that they were all very good boats. In the absence of the author the next paper will be read by Mr. Cox.

THE U. S. ARMORED CRUISER COLORADO.

BY ASST. NAVAL CONSTRUCTOR, J. M. POWELL, U. S. N., ASSOCIATE MEMBER.

ABSTRACT.

This paper, as the name implies, is a description of the armored cruiser *Colorado,* the first of her class to run her trial, which took place successfully in October. That there are 142 electric motors of 850 horse power shows the extent to which electricity is used for auxiliary purposes. Comparison is made between the *Colorado,* the British cruiser *Drake,* and the French cruiser *Leon Gambetta.* In an appendix is given in detail the service tests required for the electric auxiliaries. The results of the preliminary builder's trial are plotted in curves on accompanying diagrams.

COALING WAR SHIPS AT SEA—RECENT DEVELOPMENTS.

BY SPENCER MILLER, ESQ., MEMBER.

ABSTRACT.

This paper is a description of the apparatus patented by the author for coaling war ships at sea, and is in the nature of an account of the several demonstrations, first by the British Admiralty, then by the Russian Ad-

miralty, and, finally, by the United States government, of the Lidgerwood apparatus. This system of coaling at sea has been considerably modified, until now the apparatus is carried entirely on board the battleship or cruiser, so that the war ship may coal at sea from any collier.

DISCUSSION.

ADMIRAL BOUTAKOFF: Unfortunately, although I have no reports from the Baltic fleet concerning coaling at sea, I wish to say a few words in reply to the criticism I have heard in this country of the lack of simplicity in the Lidgerwood-Miller apparatus for coaling at sea, and that the results were rather poor. Nothing appeals to the heart of a seaman as much as simplicity. We have a proverb in Russia saying that no man who has not been at sea has ever prayed God in earnest. That proverb has the meaning that nowhere the seriousness of things surrounding people is appreciated more than at sea, and of course the simpler the surroundings of a seaman the better they are under his control and the more he appreciates them; but of course simplicity has its limits. There were many simple things that have existed, but if they remained in the same state of simplicity no great achievements could have been made. Things may be very complicated, but if we are given the possibility of handling them simply (and seamen will always be glad to have that) I positively do not see any reason why the device of Mr. Spencer Miller could not be applied with profit on board vessels on the high seas. We all know of the American engineering—the fame of American engineering is far spread all over the world—and I positively do not see the reason why our navy and the fame of the American engineering could not profit by adopting the new device of Mr. Spencer Miller for his coaling apparatus.

THIRD SESSION

The Friday morning meeting was called to order at 10:45 with the president in the chair.

The first paper to be considered was, in the absence of the author, read by Mr. Macalpine.

TIME ALLOWANCE FOR STEAM YACHT RACES.

BY REAR ADMIRAL GEORGE W. MELVILLE, EX-ENGINEER-IN-CHIEF, U. S. NAVY, VICE-PRESIDENT.

ABSTRACT.

This paper contains a description of the rules drawn up by the author for determining time allowance for steam yacht races, especially the *Haouli* cup races. The intention has been to draw up a set of rules that will make the winning of the race depend upon the design and construction of the hull and machinery and the excellence of seamanship displayed. Hence the object of a time allowance is to annul only those advantages, arising purely from physical laws, as increased size in the proportions of the dimensions and of the power installed. The formulæ given depend only upon those measurements which can be made readily and with accuracy, and are: length of water line, greatest beam at or below the water line, mean draft, and grate surface. The formulæ are according to the laws of comparison, with certain modifications which, in the opinion of the author, should be introduced for the particular conditions met with.

DISCUSSION.

THE PRESIDENT: I would suggest that you tell us, Mr. Macalpine, what the rule as established is.

MR. MACALPINE: The rule is given on page 16, under the table giving the determination of constants; the last three lines give the three terms of the rule. The first term involves length and grate surface, discriminating as to whether there is forced or natural draft; the second term depends upon the breadth divided by the length; and the third term gives the time allowance.

Then there are various conditions; that is to say, three of the terms noted at the head of page 17 were to be considered zero if it turned out to be negative. That was to cut out excessive breadth; not what would usually be called excessive breadth, but those that had not very fine lines, as it would hardly be possible to make a rule such that a very full ship should be built to win a race. Then the steam jet in the funnel was not allowed, and no by-passes were allowed to be used in the engine. Forced draft in the stoke hold or ash pit was allowed, but not to exceed 2 inches of water.

Of course much had to be done by Admiral Melville in framing these rules to gain simplicity. The necessary assumptions in all cases, I think, were made with a view to come sufficiently near a true final result and still keep the rule very simple indeed.

MR. PARSONS: Mr. President, this is an admirable peper, and seems to be a very able enunciation of the principles involved in rating steam yachts for the purpose of racing. I notice that the admiral states that the deductions are not exact, nor are they intended to be exact. And for the purposes of racing steam yachts it is well that the rating should not be exact, because that would introduce so many complications as to render the result inapplicable to practical racing purposes. Last June the speaker had the pleasure of serving on a committee which raced two steam yachts 60 miles off Sandy Hook. The yachts raced on the outward leg 30 knots, and then turned the mark boat and raced back. By applying the data obtained from that race the formula deduced by the admiral gives a result which almost exactly corresponds to the difference in the time of the speed of the two yachts. One yacht beat the other by about 4 minutes, and the formula, upon the assumptions made, would give for the two yachts 4 1-10 minutes as the time allowance, which is, of course, extremely accurate.

In respect to racing steam yachts one should be careful to get up a formula which will prevent progress toward dangerous limits. The owners of steam yachts are frequently willing to spend plenty of money in order to obtain a purpose, with the result that the sport tends toward a dangerous limit. The rules should therefore be in the nature of extreme penalties for all cases where extreme results are desired. The chief factor, of course, is the horse power, and the effort in building a racing yacht is to float the greatest power that is possible, with the result that freak designs are produced. If we could determine the horse power it would not be difficult to get up a satisfactory and simple rule for racing yachts. But the trouble is the difficulty in obtaining that horse power when the yachts are of small dimensions. Even

in the larger yachts it is difficult to get the indicated power of the engines, while with turbines it is impossible to obtain the indicated horse power. The effort has been in the past to determine the horse power as some factor either of the heating surface in the boiler or the grate surface. The speaker is pleased to note that the admiral has selected the grate surface. The heating surface does not appear to have any ratio—that is, any definite ratio—to the horse power generated, while the grate surface does bear some relation thereto. If the grate surface is too small to burn the coal or fuel the heating surface, even if it is excessive in amount, is of little value, while under the same conditions rating on the heating surface would give abnormally high value for horse power.

Unfortunately another trouble arises, that of burning liquid fuel, if we use the area of the grate as the standard dimension for determining the horse power. In rating an ordinary reciprocating engine on selecting a number of results that have been published it is found that the mean effective pressure referred to the low-pressure at the engine, and with a ratio of expansion theoretical mean effective pressure, the latter being taken as that due either to the boiler pressure or to the pressure at the engine, and with a raito of expansion equal to the volume of the low-pressure cylinder divided by 8-10 the volume of the high. That 8-10 allows for the slight cut-off in the high-pressure cylinder.

With regard to drafts the admiral named either the natural draft or a forced draft, and he limits the forced draft at 2 inches of water. From a number of records of torpedo boat destroyers it is seen that the pressure exceeds 2 inches by a very considerable amount. It runs up as high as 4 inches and over. It has gone considerably higher than that, but for economical reasons I understand that the higher limits have been barred by the Navy Department. With steam yachts there would be no such bar. A man would not hesitate to burn up his boilers in order to win a race. It does not seem fair, then, to limit the draft to 2 inches, and the speaker would suggest some other basis, say unity, and then some value for the constant (f) the admiral's formula for a jet draft, and some value for a blower draft with a closed stokehold or closed ash-pit system, and choosing those values for (f) as the maximum in either class, on the assumption that the owner during the short time the race is in operation will practically keep to the limit. The speaker would suggest a rating based entirely on the admiralty formula.

In order to prevent freak designs the speaker would divide up the classes so as to maintain yachts with approximately similar lengths and rating in one class together, and relegating any excess over the limits, maximum or minimum, to the class of a penalty charge deducted from the time allowance. Furthermore, a simple formula such as that just advocated as the basis of a rule would leave the yacht designer free, without any restrictions as to length, breadth, or draft.

Mr. W. P. Stephens: Mr. President: I am not prepared to discuss this paper on its intrinsic merits, but there are one or two points in connection with it that I desire to call attention to. The paper is most timely because there has been within the past year or two a distinct revival in the racing of power yachts. This is more marked in respect of the smaller yachts, but there have been several races run in past years with larger steam yachts, and what steam yacht racing may develop into depends upon whether such racing will ever be a regular form of sport. But there is just now an interest in it which is well worth cultivating by the larger yacht clubs.

In connection with the opening paragraph there occurs to my mind a previous attempt at steam-yacht racing, I think in 1884. The race was from New York to New London, and there were no less than five distinct systems of time allowance arranged for. Out of a dozen yachts entered almost everyone was running upon independent principles through the various time allowances. Now, there is a rule needed, I think, at the present time. It seems to me that the experience of sailing-yacht racing which is very potent, demonstrates the necessity of some recognition of displacement in any rule for steam-yacht racing. Of course a rule is important from two points of view. A racing rule for any class of yachts is used to measure existing yachts, and it may do that fairly well and act perfectly for a time, but it is worthless if we do not consider its effect on yachts to be built later. A rule may work very well for two or three years for a certain class of yachts, but as soon as some clever designer starts out to beat the rule he is almost certain to produce an undesirable type of freak.

The great lesson of late years has been the value of increasing displacement. I think the displacement of steam yachts now represents a pretty fair average of all around qualities, but if it becomes a question of building a big yacht the first thing the designer will do will be to cut his displacement; that is to say, his construction will suffer at once, and we shall obtain an undesirable type of boat in every way, lacking in accommodation, more or less weak, and lacking in durability. It seems to be absolutely essential therefore that the displacement or the midship section should find a place in the rule in order to guard against what we know is a danger in all classes of yachts.

Mr. A. A. Packard: Mr. President: Any rule that may apply to existing yachts is not necessarily a good rule. That point is brought out, perhaps, in this method of measuring grate surface. The direct draft, the natural draft, is not measured, so I should think the designer would be tempted to make an enormously high stack and a very large funnel, and so get practically a large forced draft without paying for it.

One way to measure the power would be to measure the coal. Let a certain yacht carry so much coal for a certain race. Another method is to measure merely the cylinder areas, assuming the best practice in pressure and piston speed as giving the horse power; that is, assuming that to be constant. This is a very simple thing to measure, and it works well in high-speed power boats. A third method would be to measure the propeller; that is, to allow a certain amount of horse power for a certain diameter of the propeller. Either one of those three methods would be very hard to get around and would give a simple measure of the boat's power.

The first speaker referred to the importance of a simple rule. That is very true. The admiralty coefficient applies excellently if you apply it to boats of the same length. Admiral Melville speaks of the humps

and hollows of the distance curve as not being very important, but in high-speed yachts it becomes very important, because you may take 1-3 more power for a boat of 10 or 12 feet shorter length. For this reason it is very important to class them to have yachts giving the same speed or the same corresponding speed in racing.

Colonel E. A. Stevens: Mr. President: The problem of arriving at a rule for placing two vessels which are essentially unequal upon an equality has always seemed to me one of the impossibilities. Years ago, when the question of time allowance for sailing vessels first received any scientific consideration in this country, it was deemed at the time that a solution could be reached by using the length and the square root of the sail area. The American system was to take the mean of the length and the square root of the area. The English method was that of taking a cube represented by the product of the length and the sail area. That was supposed to solve the difficulty. It was thought that we were going to have vessels normally planned, with a normal sail breadth, and with a maximum of accommodation and a minimum of sail area. The result proved to be far different. That is to say, when Mr. Burgess and Mr. Herreshoff and other gentlemen put their brains to work on the problem they beat the rule out of sight. And a like result must unquestionably follow if you take the very much more complex problem of placing steam vessels on an equality where you are going to attempt not only to tax the vessel for the opportunities the designer of the hull has had but also for the opportunities given to the engineer to create steam; and how any rule can avoid the production of freaks and racing machines is something that is entirely beyond my comprehension. That you can put the boats now built upon some fair basis of equality, some sporting basis if you will, is perfectly possible. I think certainly it can be done, and I have no doubt that Admiral Melville's solution will do it; that is, will give the majority of vessels now built a fair sporting chance, but that it will prevent the creation of racing machines seems to be too much to hope for.

If we are going into the question of racing it seems to me we shall have to come to what is the best sport. We shall have to make a class of vessels of practically identical designs, stipulating exactly what a man may use, and restricting him as against undesirable features and then allowing him to go ahead and produce a racing machine to that extent. We may go as far as to force a man to build a vessel from certain particular drawings, and with a certain particular size of cylinders with a particular stroke; and I suppose we shall go as far as to give him his propeller design. And then it will become a question for the engineer and the designer and the captain—the captain keeping his bottoms clean, and the steersman keeping his proper course. At the same time, given a set of arbitrary conditions in that way, you are going to make it possible for men to make race boats. But if you are going by the other scheme a class of boat is built to race this year, say; but next year, somebody, profiting by the experience of the past year, will build something which will make all the rest look silly; and those five or six boats will go into the junk heap as far as racing is concerned. It seems to me, therefore, that the policy of yacht clubs ought to be, if they are going to encourage steam yacht and power boat racing, to limit the classes closely, so that the designs will all be limited within very close limits, and will require merely the exercise of careful design and making the best out of conditions which in themselves would not admit of anything but one special type of vessels.

Mr. Macalpine: In reading through his paper you will notice that, as far as he thought he dared, the admiral has set his face determinedly against freak yachts. As a matter of fact, whether it was for this reason or any other, there were no such yachts entered for that race. Of course the question of liquid fuel is a very difficult one to deal with, and there are comparatively few yachts, or so few, fitted with it, I think, that it was hardly worth while upsetting the old construction to include it.

The question was raised by two speakers as to how the horse power was to be measured, whether by the coal burned, or the cylinder area, or the propeller. Of course we all know—all who have run trials—that the coal burned and the horse power got out of it depend very much on a great many circumstances, and it could hardly be taken as a fair measure of the power at all. If you have a certain grate surface, your design being otherwise good, given skilfull stokers and a proper engine (of course the better the engine the more credit the designer should get, and the more chances he would have in the race) then you have a fair measure. The heating surface would not give you any fair measure, especially if you had different types of boilers aboard.

Then, as to the question of forced draft, if more than 2 inches are allowed, the torpedo boats having been run with more than 2 inches, Mr. Parsons said that a keen sportsman would be willing to burn up his boiler in order to win the race, and consequently should be allowed more than 2 inches of draft to do it with. I think he should rather be severely cut down so that he is not going to burn his boiler, and therefore that a strict limit should be imposed.

In the paper the admiralty coefficient has been distinctly departed from, and in high speed boats that surely is correct, as the admiralty coefficient is very far from correct when the wave making resistance comes to be a very prominent element. That is to say, even with boats of moderate speed, we find, looking over the data of progressive trials, that the Admiralty coefficient is anything but a constant, and it has to be handled with very great care.

The question of the periodic variation of the resistance came up. Of course that would be very interesting to take into account if it were at all possible, but I don't imagine that it is possible to do it without considering each yacht by itself, and of course that would make anything that could be called a rule an impossibility.

Then the question of displacement arose. Of course, if you have a certain length and breadth and draft, and you begin to alter the displacement very greatly—that is to say, cut the displacement—you run yourself into a very great many difficulties. To begin with, you immediately run down our power of carrying any weight of machinery; and I should think that the specification

of the elements of length, breadth, and draft, and engine power, or grate surface, which practically measures it, would limit you within very long limits, and would require great intelligence to make the best choice of the displacement.

There is one note that I would like to make in connection with what Colonel Stevens said. He proposed exactly the same design for all yachts. Of course this rule was made by Admiral Melville for yachts already existing. There was no proposal to build special yachts. There was no time to build special yachts Consequently any limitation as to what the design of the yacht was to be would not answer at all. In fact I didn't imagine until the interest in the race got up to the pitch that it has in regard to these America cups, that we would ever have so much money to spend on building racing yachts. I think that is all I need to say on the subject, except to repeat, of course, that this is not Admiral Melville's reply, and what I have had to say in reply should be cut from the transactions.

ON THE RULES OF LLOYD'S REGISTER FOR BUILDING YACHTS TO CLASS.

BY GEORGE STANBURY, MEMBER.

ABSTRACT.

This paper describes the new yacht rules adopted by Lloyd's Register, after consulting prominent yacht designers, and is formulated for the purpose of complying with modern design and construction. The principal change has been the introduction of a new measurement termed the "bilge diagonal" in ascertaining the rating numbers. While the previous rule made use of the measurement, one-half the girth, this did not satisfactorily discriminate between normal full forms of ordinary steam yachts and racing yachts of fine form. The scantling basis adopted under Lloyd's rules for all types of yachts is practically the same as was formerly used for steam yachts, but with the modifications of the above-mentioned bilge diagonal. The rules have not only been modified but many additions and extensions have been made. Numerous illustrations have been added showing approved methods of construction in wood and metal.

DISCUSSION.

PROFESSOR SADLER: Mr. President: This paper is, I think, exceptionally interesting in that an attempt has been made to introduce the displacement by means of this bilge diagonal N. We all know that the binding moment varies as the product of the displacement of the vessel and the length; and the sheering force may also be taken to vary with the displacement; so that in fixing the scantling of any vessel really the displacement should be a governing factor. And it is very interesting to see that this factor has been practically introduced into this new rule by means of the bilge diagonal N. In regard to the length, it would be obviously unfair to vessels with a straight stem to let them have the same length for scantling purposes as those with large overhangs.

It is also interesting to note that although no mention has been made of the straining action due to sails, or the deep lead keel, that this is implied in the measurement of girth and depth; by taking the depth of the bottom of the lead keel a tax is at once put upon the ballast and the straining action.

MR. STEPHENS: Mr. President: This paper deals with a subject whose importance is recognized at this time more than ever before on both sides of the water. There has been no attempt in the country to restrict the scantling of yachts until within a very few years. About eight years ago I was called on by the Yacht Racing Union of the great lakes to prepare a table of scantling for their yachts. This I did, expending a great deal of time in rather an unknown field, as nothing then in existence covered the particular case of the yachts as they then existed. This table worked very well. It is still in force. A number of international races have been sailed under it, and, I think, it has proved successful. The only important change has been that, while I did not attempt to limit in any way the materials, that has since been done. Men were found to be using white pine where oak should be used, and they have supplemented the original table of sizes of scantling with the limitation of materials for certain parts. These same scantlings—that is, this same table of scantlings—has since been used in the east, about Boston and New York, with modifications to suit local conditions, and within its limitations it has worked pretty well.

At the present time all yacht clubs and yachting communities are alive to this question of the advisability of some limitation to light construction. The trend of designing of late years has been to cut the displacement, and that means to cut the construction; and yet it is safe to say that the designer to-day knows no limitation on his work as to cost. Given an amount of money, and a pretty liberal amount, he will cut the weight of any existing yacht by quite a fraction.

At one time Lloyd's tables were based on the current practice of the day in yachting, as that practice was developed in England, to the cutting off of beam and the addition of lead to keel; no attempt was made to follow the course of evolution in yacht designs, and designers had a free hand for many years. Of late years, and quite recently, in answer to the demand of yachtsmen Lloyd's rules have been very thoroughly amended, and they stand to-day, I think, as an index of pretty good construction. Now it rests with the yachting clubs to deal with this subject in some active manner. It is under discussion all the time, especially the subject of imposing some scantling regulations, and it seems to me that Lloyd's rules as they stand offer a practical working basis. They have been framed with great care, and after an enormous amount of experience. They represent years of change, and constitute a good working basis for the adoption of scantling restrictions which are so obviously needed in yachting. I think, therefore, that more may be obtained by working in harmony with Lloyd's to improve the existing rules, if necessary, than by making independent and conflicting measurements.

In the absence of the author Mr. Cox then read the following paper.

THE POSITION OF THE CENTER OF LATERAL RESISTANCE.

BY L. E. BERTIN, ESQ., MEMBER.

ABSTRACT.

This paper is a treatise on the position of the center of lateral resistance based upon experiments on models of a few typical vessels carried on by the author several years ago. This point is that at which the resultant of all forces tending to resist the lateral motion of the vessel must be applied. Its position is not generally known. Such knowledge, however, although not of the first importance, is of practical value in calculating the heeling moment of sailing vessels, or in investigating the angle of heel produced by some vessels while turning.

DISCUSSION.

MR. PACKARD: Mr. President: I see no mention here made of the length of the rudder. The depth of the rudder is also a significant factor. Whether you have a rudder up near the surface of the water or have a deep rudder makes an enormous difference. The forces in action when the boat is turning are the centrifugal force and the lateral resistance, and this of course depends on the rudder. The rudder acts in an opposite direction to the lateral resistance. If the boat has a long, deep keel it takes a great deal of power to turn her. The effect of the rudder is great if she has a short keel, and it takes very little power to turn her and the form of the rudder is comparatively unimportant. I am told that in designing torpedo boats they depend a great deal on the rudders to prevent them from capsizing. In some of the early types they had a shallow rudder, which allowed the boat almost to capsize in turning rapidly; then they made a deep one and entirely obviated this risk. The depth of the rudder is therefore very important in matters of this kind.

Another important point in designing high-speed steamers is the shape of the fore-and-aft lines, from which a good deal of difficulty sometimes arises in respect of the lateral resistance. If you have a boat with a flat keel, as illustrated in Mr. Crane's paper, this difficulty is in a great degree overcome; this is simply due to the fact that the boat had a flat keel and the fore-and-aft stream line and diagonal lines are very nearly horizontal instead of semi-circular. The Herreshoffs found that out about 20 years ago, and in designing high-speed vessels of all kinds they pay a great deal of attention to the shape of these fore-and-aft lines. That has a good deal to do with the resistance, and it is not necessary to make a broad stemmed boat in order to prevent this difficulty.

MR. HOVGAARD: I happen to think of a very good illustration of what the last speaker said about the torepdo boats being affected by the rudder. Some 15 years ago we had a small torpedo boat in the Danish navy—No. 10—which had two rudders, but she had had very little stability. She was out one morning when there had been some rough weather during the night and there was a heavy swell running outside off the port of Copenhagen. The boat was of only 15 or 16 tons displacement, but she had occasion to turn very sharply. She used the full power of the rudder and was going at full speed. In turning she was all right, because the rudder acted against the centrifugal force. She would heel over out of the circle, but the rudder being placed below the center of gravity would keep her up; but the moment the helmsman eased the rudder, which he did very suddenly, the boat turned over and sank immediately. That, I think, is an interesting illustration of that point. The boat had a sister vessel and we reduced the area of the rudder practically 5 per cent. after that, and lowered the center of gravity somewhat by placing some ballast in the bottom of the boat. Then we tested her, and still, at full speed and with the full rudder, she would heel over a good deal, and showed the same tendency when we eased the rudder. When the boat I speak of capsized the action of the sea, of course, had something to do with it.

MR. MCLEAN: Mr. President and Gentlemen: Mons. Bertin's paper seems to have been written chiefly to disabuse the minds of the average person of the ordinary definition of lateral resistance. Usually it is taken at the geometrical center of gravity of the longitudinal plane. Here it is taken at the center of the resultant forces made up of the resistance of the air and of the fluid pressure underneath. It is very nicely shown in sections of Mr. Webb's vessel, the *Donderberg*. Everyone knows that the center of pressure is one of the hardest points to calculate, and the writer has gone on to state that by the result of actual experiment he has found the outer position of the center of lateral resistance to be at the point *O*, and I believe he has indicated the only way of finding it.

MR. MAIN: Mr. President: The remarks as to the center of lateral resistance as we find it calculated, and as we find it here, are followed by the record of two experiments. These, I think, are useful only for comparing with data derived from other models. I think the truest way to get the center of lateral resistance, or to know the relation of the center of pressure to the center of lateral resistance, is to make a model of the vessel as near as possible and rig her up and sail her; and then you will find that the position of the sheets and the strength of the wind have very much to do with the lateral resistance when the vessel heels over. Then, of course, the center of lateral resistance travels forward, which also gives greater moment between the center of true lateral resistance and the center of impulsion of the sails and sends the boat up into the wind. I think that is a point often lost sight of by many yacht designers and naval architects.

THE PRESIDENT (taking the floor): Gentlemen: I take pleasure in coming down on the floor again for a moment to remind you that the chair cannot discuss these papers. But I have felt that it was necessary for someone to come down and stir you up, as I have had the pleasure of doing in old times, and to prompt a discussion of the papers which come before us. Every remark adds some value to them and to the value which they convey to the members who are not present. It has been a great pleasure to me to find such an old friend as "The Center of Lateral Resistance" could arouse so much discussion as it has already. I feel

sure that there are still others here who have made some experiments upon this matter in the course of their yachting experiences which would be of very considerable interest and value to many of our readers, and I earnestly beg of you to take a more active part in the discussion of papers which come before us. It will add very much to the pleasure of my duties in the chair.

In the absence of the author the following paper was read:

SUBDIVISION OF WEIGHTS IN SHIPS' DISPLACEMENT.

BY NABOR SOLIANI, MEMBER.

ABSTRACT.

The vagueness and uncertainty of the exact meaning and classification of weights of war ships and merchant vessels is appreciated by all who have to do with their construction or equipment. Such want of precision is also due to the complex character of the ship itself, which makes it difficult to tell where one part ends and the next begins. The author has written this paper with a hope of inducing some step being taken for the avoidance of this vagueness with relation to weights, and he proposes for war ship classification one which is followed by the Italian royal navy, and has proved to work successfully in practice. The ten subdivisions of weights proposed are as follows: Hull; hull appurtenances, viz., machinery, accessories, and fittings to hull; armor and protection; propelling machinery; military armament; electrical generating plant; navigating outfit; fuel; equipment; margin (corresponding to cargo in merchant ships). No classification, however, is satisfactory unless the boundaries between classes are distinctly and clearly drawn in every particular, and the author devotes several pages to describing the limits of each classification. The classification for merchant steamers and sailing vessels is along the same general lines, but naturally is simpler and eliminates certain headings.

DISCUSSION.

Mr. Hovgaard: Mr. President: I can only say that I hope the suggestions contained in this paper will be acted upon. I think it would be extremely useful to all of us if it were possible that such subdivision, clearly defined subdivisions of the weights, could be arrived at. Fortunately in the weight department in the Bureau of Steam Engineering they have a very clear definition of what is involved in the different groups. I think it does not matter very much how the grouping is effected, but, of course, it must be on some rational base or principle; but it does not matter so much if it is clearly defined and everybody knows the definition. There are, however, points in the grouping which are important, and I think that the armor deck ought not to be grouped under the hull, but, as Mons. Soliani recommends, the vital part of the armor deck, that is really a protection, should be reckoned to the armor weight, and that only that part which is equivalent to what it would be with an ordinary deck should be reckoned to the hull; for otherwise, in comparing ships with different shapes of armor deck, it will appear that one hull is constructed much heavier than another when it is really not so, which is, of course, unfair, because the excess of weight is really a matter of protection and not of hull construction.

The President (taking the floor): Gentlemen: It seems to me that in connection with this paper it ought to be understood that the Navy Department and the construction officers of our navy have probably been more generous on the subject of information in regard to weight than those of any other government. The Navy Department has a most complete classification of the weights of the hulls known to exist anywhere, I believe, a classification prepared with the utmost care, and one which has been in existence now for a number of years. The return weights of the vessels built for the navy have now provided a mass of data which makes it possible for the designing of new vessels to proceed upon lines of some certainty. It is to be regretted that the author of the paper could not have given us some weights of some of the Italian vessels in which we are considerably interested. It would have been most valuable to us to have known, for instance, the amount of the item of margin upon the *Victorio Emanuel,* which has never seemed to me to ever have had other than a negative existence.

FOURTH SESSION.

The meeting was called to order at 2:15 by the president, who was afterwards relieved by Mr. E. A. Stevens, and later by Mr. Stephenson Taylor.

MAINTENANCE OF MACHINERY IN MERCHANT SHIPS.

BY ROBERT HAIG, ESQ., MEMBER.

ABSTRACT.

This paper is one of the most valuable practical treatises which have been presented to the society. The maintenance of machinery in merchant ships is a problem that is steadily becoming of higher importance by reason of the increased size and power and of the great complexity of machinery now found on board high powered vessels, and also because of the increased demands now made for a higher efficiency in machinery and the personnel of engine room. The author, who is a surveyor of a classification society, has had abundant opportunity for noting the defects and breakdowns in marine machinery, and treats, under the heading of engine fittings, shafting, condensers and boilers, forced draft, oil fuel, superheated steam, steam pipes, and pumps, of the care and attention that should be given these parts for their efficient maintenance. His observations are not only general but take up in detail those points about the boilers and engines which are the greatest source of trouble to the engineer and which require the most careful attention. Under the heading of boilers are given perhaps the most valuable remarks concerning the points where weakness, distortion, and cracking of plates are generally found, and the way of running boilers to reduce such troubles to a minimum.

After reading the paper the author made the following comments and explanations:

After the words: "The packing of condensers is generally supposed to be a simple operation" (page 5), the speaker added: The reason I say that is because I have often found that it is a job which is entrusted to

apprentices, and is supposed to be a job that does not require any great skill or experience.

After the words: "In some ships corrosion in copper and other pipes in the bilges have been traced to the use of certain animal or vegetable oils" (page 7), the speaker added: The Russian volunteer boats having mostly copper pipes in their bilges, have had no end of trouble. These ships were built to class with Lloyd's Register, and we know that they have had a great deal of trouble, and much of it was found to emanate from the fact that they use olive oil, a vegetable oil. They found that there was a very active corrosion. The copper pipes would many of them fall to pieces.

After the words: "Mr. Yarrow conducted a series of experiments in 1891 and showed conclusively that with every change in temperature the conditions of the tube plate and connections changed proportionately" (page 11), the speaker added: Mr. Yarrow took a type of old-fashioned locomotive boiler and made experiments with it. He carefully noted that the effect of opening the furnace door was to lower the temperature. When the furnace was at a high temperature the tube plate was pulled in, and when it was lowered it was pushed out. And the change went on with perfect regularity, which proved that there is an expansive movement there.

After the words: "It is, however, not desirable to raise steam too quickly," etc. (page 17), the speaker added: There is another feature to be considered if you get a big power of engines. Some time must elapse before you can warm the engine up to full power. Even supposing you had the steam, it is a very rash proceeding to start away with engines not thoroughly warmed up.

DISCUSSION.

Mr. Wheeler: The subject of the deterioration of tubes is a burning question, but I think a great deal of the trouble is due to bad material. Of course, it is very desirable to get homogeneous tubes, but it is very difficult to get them. Electrolysis, however, has more to do, I think, with stationary plant than aboard ship. In many cases, I think, it is pure and simple galvanic action which causes the trouble, and this is more or less affected by the quality of the circulating water. We find, for instance, in New York harbor, that boats lying around docks have more trouble with their condensers than sea-going vessels. I have in mind some boats that were occupied a great deal on a branch of the East river near Greenpoint, among the oil refineries, where they were obliged almost to give up the use of surface condensers. In fact, one of the largest owners of tug boats (I think it is the New York Central) has practically abandoned surface condensers for jet. Even now they have trouble. On the Passaic river they have had no end of trouble, even with jets. Of course, we know what the Passaic river is. It is nothing more or less than a system of sewers, with animal substances coming down from those sewers and all the outlying villages as well. I have in mind a case where the valve bolts in the air pump wore down to almost 1-10 of their diameter.

I have found in condenser tubes, where the circulation was not uniform, that some have been doing more work than others. Those were the tubes that were the first to go. In the case of double tube condensers, annular tubes, I also found a very remarkable effect. At the end of the inner tube, where the current passed and turned around and came back, it would actually cut a hole just as if a file were used, at one particular spot, at a certain distance from the end of the small tube, through a combination of chemical and, you might say, mechanical action. The practice of the navy is to place zinc not only in the condensers but in the pipes, and even in the pumps, or wherever they can get a piece of zinc conveniently placed. In fact, I saw one design in which they placed short fingers of zinc into the pipes, which could be readily taken out for repair, or for being replaced with new pieces of zinc when worn out.

I would like to call attention to another point. Mr. Haig speaks of packing condenser tubes. There is nothing that should receive more attention. You have to allow for expansion and contraction. But I find that this is a very useful way of reducing to a minimum the number of packings. (Illustrates on blackboard.) This is one end of the tube, thickened, like that—cutting a slot here, and chasing the thread here, and securing it right into the tube here (indicating). This end of the tube plays through the usual packing. We provide for expansion and contraction at one end of the tube, and for anchoring at the other end.

Mr. Haig hardly touched upon, in fact, he omitted it from his paper, the subject of pumps. As in the case of many other auxiliaries of ships, enough importance has not been given to the subject of pumps. People are not willing to spend enough money on them. I refer to this country. It is not so abroad. I hardly agree, however, in the suggestion that the valve seat should be cast solid with the chamber of the water cylinder, and for this reason, that it makes a more expensive pump of it, and it is hard enough to get people to make use of a more expensive type of pump. They usually buy iron pumps brass fitted, and if you cast them in the way suggested it makes it very expensive. Valve seats can be put in or driven in to suit, but there is always a possibility of their coming out. But at the same time the problem has been solved with fair success, and the last dozen or twenty battle ships and cruisers have brass composition decks, with the seats solid with the deck; in other words, there are groups of small valves not exceeding 2 inches in diameter. I don't believe in large valves, unless you want music. Of course, the modern practice, in the case of the higher pressures, is to have the valves enclosed in castings called pots, thereby reducing the weight to a minimum, and bringing up the strength to resist the higher pressures now prevailing.

I think that it is a very wise thing to reduce the steam pressure, and certainly it is more economical in the matter of pumps, because we have not there the elaboration for expansion and contraction, and we all know that the greater the range of temperatures the greater the cylinder condensation; besides, this method is more practical and less liable to break down, and requires less weight. I would suggest 125 pounds as a very good maximum figure for such auxiliaries as the pumping plant. This is a very good pressure on economical grounds, and people should look a little more to economy in these auxiliaries. There is no reason why we should use from 20 to 40 per cent. of all the steam generated in the auxiliaries, though you will find, if you investigate the matter, that that is the rule. But among the

best type of auxiliary machinery I believe they have got it down to somewhere between 10 and 15 per cent.

A Member: For long trips?

Mr. Wheeler: Yes, for long trips. But the average is about 35. A paper read here yesterday showed that the indicated horse power was only about 5 per cent. of that of the main engine. A paper read before this society not many years ago showed that on the *Minneapolis* the electric generating engine took about 100 pounds per indicated horse power. True, the valves were not in very good order, and the party overhauling them got it down to about 50. You may imagine how much coal was necessary.

Mr. Forbes: The supplementary remarks about electric light plants I am glad to see in one way, and sorry in another. They don't admit of any such consumption of water to-day. The government is particularly exacting.

Mr. Howell: I remember very well a paper written by Assistant Engineer Hall of the navy. During a two years' cruise he made exhaustive water tests of all the auxiliaries, and I think some of the results showed as high as 200 pounds per indicated horse power, for instance, on high-pressure steam pumps; and it has always seemed to me that while the large increase of auxiliary machinery on modern vessels is a great convenience to the engineer, it would be a very good thing if we could go back, to a certain extent, to the old style arrangement of air, feed and bilge pumps driven from the crosshead. I don't see how the water consumption can be cut down to any great extent with the elaborate arrangements which we have to-day. Compound acting steam pumps are, of course, better than the simple steam pump, but even on those the consumption is growing.

There is a passage on page 17, in regard to water-tube boilers, which meets my idea exactly. We found on the *Minnesota,* which I guess has about the largest installation of water-tube boilers in merchant work of late years, that it simply came down to a little more than a question of the intelligence of the fireman. It was a matter of the water tenders looking out for the water. And my idea, since that experience, is that it would be better to cut out all the automatic feed arrangements from water-tube boilers, and put them on the same level as Scotch boilers; that is, put it to the water tenders to look out for the water level. They will have to pay more attention to business than with Scotch boilers, but that is the only basis upon which they can be run. Automatic arrangements on the boiler for regulating the water level are simply a bid for carelessness and disaster.

The President: Any further remarks? Does the society understand that our old friend Water-Tube Boilers is up for discussion? It seems to me that some of the engineers might give the society some very valuable information on the question of propeller shafts.

Mr. Haig: Regarding what Mr. Wheeler said about valve seats and pumps, what he said about a number of small valves being grouped on the plate is simply what I have indicated; but that driven-in valve seats are a nuisance has been proved again and again. In a trial trip of a boat that I know of the trip was practically stopped on account of the valve seats coming out of one of the feed pumps. In my opinion auxiliaries get very scant attention. I usually find them in a very inefficient condition, and I can only infer that they do not receive anything like the attention that they ought to.

Mr. Wheeler: Don't you think that people who install these auxiliaries do not show the care they might?

Mr. Haig: I am not speaking of those who install them, but of those who attend them.

Mr. Wheeler: There is no use having a good thing if it is not taken care of with the greatest intelligence. I find that many auxiliaries are not done justice to in order to keep them up properly, and those who have charge of them have great fault to find with them for that very reason.

Mr. Howell: The trouble with some of these elaborate outfits of auxiliary machinery is that it is impossible to give them the care which they ought to receive. I remember on the *Ohio* some years ago I asked the assistant engineer in regard to the construction of the heater. He said: "I don't know what the construction is. It works, and that is all; I have never had a chance to open it."

Mr. Wheeler: If you have a good air pump exhausting into the receiver of the engine or into the feeders you practically have a connected pump. You simply take out of that steam a certain amount of heat and pass it back to the engine, with this advantage, that you can regulate that pump to any speed you like. And what is more, you are not troubled in your mind about the breaking down of the pump. A few accidents which occurred on the Cunard line on ships were due to the smashing of the air pumps when the ship got to racing.

Mr. Howell: Of course, in those things it is a matter of compromise. There are advantages and disadvantages. My idea was simply that it would be well to cut down as far as possible some of the auxiliaries. I think that in some of the ships it has been carried too far. Of course there must be danger in racing. But some of the air pumps that I have seen lately have raced, and auxiliary air pumps have raced. They have gone at a terrific speed. Of course, it is a great advantage to have an independent air pump and a circulator, but it seems an unnecessary thing to go to this expense to save steam, and then put in a set of auxiliaries which are admittedly wasteful. It seems almost like saving at the spigot and wasting at the bunghole.

UNIFORM SPECIFICATIONS.

By W. D. Forbes, Esq., Member of Council.

ABSTRACT.

The argument of the author for a uniform specification is based upon the reason that the builder who is held responsible for the machine supplied should himself decide what materials go into the machine. One of the abuses of some present day specifications is that they do not specify, but demand information which the builder considers a trade secret. The builder who has made a life study of a certain type of engine naturally knows more about the requirements of such a machine than the purchaser. In concluding, the author holds that if there is a specification for an article it should be lived up to, else the article should be entirely rejected; that no responsibility should rest on the maker except for good work; on the other hand, if there is no specification, the maker should be held responsible by

bonds for the satisfactory working and lasting qualities of the article.

DISCUSSION.

THE CHAIR: You have heard the paper read, gentlemen. It seems to me there is meat in it for discussion. We should be very glad to hear from any one of you. It seems to me there are one or two suggestions in this paper that are worth taking up. This last one strikes me as rather a peculiar one. I think by the time the writer has been a constructor as long as I have he will not desire to be asked to give bond for anything. This question of what is first-class is also a very peculiar one at times. I have written a great many specifications and have read many more, in which there has been called for workmanship of first-class character and material of first-class character, but just what is first-class is always left indefinite. The matter of specifications, therefore, has always been for me a very peculiar one. I very well remember many years ago that Captain Bradbury came from the Pacific ocean to contract for two steamers to be built here, to be carried over and delivered in San Francisco harbor. After some little talk about the general dimensions he gave the company of which I was then a member the contract to build the machinery, and the president remarked: "We will prepare the specifications for you and present them with the contract." And the captain, with a sort of dry smile, said: "No; I don't care about any specifications. I understand you furnish it all complete in the very best manner." The result was that there was nothing left out, I assure you.

The two following papers were then read, and as they referred practically to the same subject they were discussed together.

HIGH SPEED GASOLINE LAUNCHES.

BY CLINTON H. CRANE, ASSOCIATE.

ABSTRACT.

In this paper the author points out the great development made in high speed gasoline launches during the last year, and especially with regard to the engine. By reducing the weight to a minimum and by adopting the automobile type of motor, a brake horse power is now obtained on from 8 to 20 pounds of machinery, which is 1-10 the average weight of the older makes of motors. This reduction has been accomplished, first, by cutting out unnecessary material, the employment of higher grade material, and the use of higher piston speeds. The balance of the paper is devoted to a description of the *Vingt-et-un*, designed by the author, and to a series of trials unusual for this type of vessel. Runs were made over a measured course with engine speeds between 380 and 850 revolutions, with a view of obtaining the rate of increased power at speeds not already investigated. The results of these progressive trials are plotted for propeller efficiency, apparent slip, resistance in pounds and brake horse power, with the varying speeds.

SPEED AND POWER OF RECENT MOTOR BOATS OF SEVERAL TYPES.

BY ALPHEUS A. PACKARD, MEMBER.

ABSTRACT.

This paper presents in tabular form the data collected by the Eastern Yacht Club on the speed of fifteen motor boats. The club desired to obtain exact figures on this subject and, therefore, during the last summer, speed trials of these vessels were run on which the observations were most carefully and accurately made. The dimensions of the boats tried are recorded in a table accompanying the paper, and the speed formula for rating given by the American Power Boat Association is discussed. Several photographs of power boats going at different speeds are appended, and the author endeavors to show that at increased speeds the frictional resistance increases at a lower ratio beyond the "critical speed."

MR. PACKARD: A great deal of care was taken in checking the results, and I think they are very accurate. The parties very kindly allowed me to use their data, and I have added some other data obtained from different sources. (The author then described the wave formation shown in the illustrations accompanying his paper.)

In a high-speed boat there is undoubtedly up-hill resistance. The vessel is supposed to be very small, and is on the side of a very large wave. The buoyancy of the water acts at right angles to the wave's surface; that is, it extends backwards in these resultants. Attention was called to this matter by the elder Froude in the discussion of his paper in 1877 before the British Institution of Naval Architects; and then, again, in 1881, the younger Froude didn't mention that, but accounted entirely for the resistance as due to the coincidence of the wave crests. This undoubtedly applies to boats and ships up to the time when they are making a wave as long as this is. When they are going faster than that there seems to be a new law which has been very clearly brought out by experiments this year; and that refers to the up-hill resistance. The coincidence of the bow and stern system of waves does not make much difference to the resistance, and I think the humps and hollows—to reason backward—in the more moderate speed boats are probably due to this up-hill resistance. If you will notice Mr. Froude's paper you will see that whenever the stern is unsupported a hump arises, and he explained it as being due to the neutralizing of the bow system of waves counteracted by the stern system. The changes at this high speed can be accounted for by pulling the boat up hill as well as up the coincidence of the wave system. Mr. Froude called attention to the fact that the diverting bow system of waves, after they leave the boat, do not, of course, affect the boat's resistance. And the power required to create these bow waves is not given back to the boat in any way. The only power given back is due to the transverse system of bow waves punching the stern and pushing the boat along. And this undoubtedly accounts for part of the resistance at these more moderate speeds. The wave making is enormously important. There is one more point to call attention to, namely, the importance of the wave making, as shown in these diagrams. The American Power Boat Association's rule was used for figuring the ratings, and the power for a certain speed varies enormously.

DISCUSSION.

PROFESSOR SADLER: In the first paper Mr. Crane rightly points out to what this has been due, and especially to the elimination of unnecessary material, and to

the use of higher piston speed. At present the maximum piston speed at which most of these engines have been run is in the neighborhood of 956. That is not at all excessive when we come to think of the piston speeds in use in torpedo boats at the present day; and although it might be thought a little dangerous to go much higher than that, personally I don't see that further advance cannot be made in putting up piston speeds still higher. I would like to know if anybody has had experience with gasoline engines run at piston speeds in the neighborhood of 1,400. In automobiles some of them do no doubt run at a higher speed than 956, and there is no reason why they should not be utilized in boats of this character. The attainment of these high speeds, of course, has been due also to the elimination of useless material.

With regard to the second paper, as to the question of the coincidence of the bow and stern crests, I agree with Mr. Packard that that accounts for very much in regard to this high resistance, especially with a length of wave that is formidable in comparison with the size of the vessel. In regard to the other point, that is, this up-hill motion, I am not quite sure that I understand what he means, but I think there is no doubt that the variation that occurs in the resistance curve is due to wave forms of some kind.

Colonel Stevens: I would like to ask whether the curve which the author plots as the resistance curve in his paper is the same as the figures which he derives from actual experiments?

Mr. Packard: Yes.

Colonel Stevens: I made some figures, and it seems to me that there must be residuary resistance. It looks as though the vessel would rise in a body out of the water and lose a large part of the resistance. The boat seems to behave very much like the flat stone which we used to make skip over the mill pond when boys, or like an æroplane. But certainly the problems raised are exceedingly interesting. I would also like to ask of some of the gentlemen who are more in touch with the question of autos than I am, as to the relation between the rate of horse power as calculated and the actual power developed in practice. Mr. Crane's case is that of an actual test and the only possible source of error seems to lie in the possibility that the engine might not always be working exactly as in the test.

Mr. Packard: I think Mr. Crane's work is a wonderful achievement, from the way she maintained her speed in rough water. I think that is a great achievement, as these little boats are often in rough water, for Mr. Crane has made a boat that is less affected by the roughness of the water than any in existence. Another thing he has done: that is, he has made a boat which does not change her trim much if any, although she has a narrow stern instead of a broad one. He shows that it is not necessary to have a broad stern to prevent a boat from changing her trim.

The curves are very interesting, especially the one that shows that as you go faster the slip of the propeller is less rather than more. I think in that case it is due not to the boat rising out of the water but to the fact that in the higher speed the propeller is getting closer to the crest of this first bow wave. If the wave was indefinitely larger and the boat very small the propeller would be right on top of the bow wave, and, of course, there the water is moving with the boat; that is, it not only adds greatly to the efficiency of the propeller but it also reduces the skin friction enormously. These two causes help the boat greatly to go at high speeds. Of course, some models do rise bodily out of the water. Some of the torpedo boats certainly rise out of the water when going at full speed. And this also helps to get higher speed in these boats.

A Member: Considered by itself, there is, perhaps, no reason why this speed should not run up much higher, but there are a great many practical difficulties in the way. One of the most difficult things to deal with is the matter of vibration. These engines are run, some of them, at as high a rate as 1,400.

Another point has been raised in the discussion, and that is the horse power of gasoline engines. The speed is so high and the power would be so great that an indicator card would not show anything. I understand they have introduced in Germany a photographic method of indicating measurements. Of course, the only fair or genuine test that is worth anything as to the power of a gasoline engine is an actual test. You can't figure it out as you can that of a steam engine under different conditions. The condition of the weather will affect the gasoline engine. A damp day or a dry day, when the pressure varies—all these things will affect the engine. Of course, under a certain set of conditions, you would always get a certain horse power, but who shall say that these particular conditions all exist during the course of a given trial? You can't expect extreme accuracy unless you have repeated brake tests made.

Mr. Witherbee: The horse power corresponding to a given number of revolutions in the laboratory need not necessarily mean the horse power corresponding to the same revolutions in a boat. The torque in a boat increases very much more rapidly than the ordinary torque. In reference to the question of the boat rising out of the water it is a fact that there has been more or less published on that subject to the effect that a boat usually commences from a stand by gradually increasing the speed, and then the boat sinks as a whole—that is to say, the center of gravity sinks. In other words, if you take the mean height at bow and stern from any given fixed plane of reference, the center of gravity of the boat settles until you get up to a speed which ranges from 8 to 15 knots, depending on the size of the boat. After that the boat begins to rise. But speeds have never yet been attained at which the boat rises enough so that the center of gravity has the height that it had when the boat was standing still when you refer it to the plane of reference. In other words, the boat is always lower in regard to some fixed plane of reference than when standing still, although the tendency is to come nearer to this plane of reference as the speed increases.

Mr. Cox: In looking at the question generally as to what results we get apart from the interest which there may be in these freak boats, it seems to me that we ought to expect actual aid from the Navy Department. Sooner or later the department is going to be interested in extremely high-speed boats driven by gasoline engines. But the department probably will not take up the matter definitely until it feels sure of its ground, and the yacht designer and the owner will have to go to a great deal

of trouble and expense in making experiments. But if we could prevail on our friends in the department to run tests in which the actual and relative speeds approach those that are realized in these exceptional cases, such tests would be of great use. There is no model experiment that I know of in which the speed is anything like what is now realized by the gasoline boat, and the whole problem of design confronts us when we approach these new conditions. In many freak boats results are established that we cannot understand. We don't know the efficiency of the propeller, and we don't know what the engines are doing. If we could get complete resistance curves it might aid us in avoiding going into the extremes of freak designs.

MR. WHITTLESEY: I would like to ask Mr. Crane if he would enlighten the society on the steering qualities of his boat in a sea way at a high speed. I understand that she is an unusual boat. A good many designs have a high-speed form, but not so many designs have a high-speed form which is good in a heavy sea way.

MR. STEPHENS: At the present time the automobile boat sport is largely without direction. There is an association here which has laid down a rule which seems to work pretty well, and it regulates the races and has done a certain work. But this does not fill the bill. It is a question with me whether, in the line Mr. Crane has indicated, there is not a chance for much wider experiment. They are making phenomenal speed, and there are going to be a good many of them run. Now is this new movement worthy of the encouragement of the Navy Department and of the ship builders interested in torpedo boat designs? Isn't there something which can give the movement proper direction at this time? In this connection the Eastern Yacht Club has done some very good work in a small way this year in making public the results of their races. They have only held a few races, but the committee, of which Mr. Packard is a member, has kept careful records of all the races, and they have tabulated all the measurements of the boats. They have published the result in an admirable little pamphlet which shows exactly what they have done. If other clubs would do the same thing it would do a great deal for the advancement of the sport.

MR. CRANE: There have been several points brought up in the discussion which I could and would have touched on in the paper but for the fear of growing tedious. There is no question in my mind that the boat does rise with reference to the water about her, and there is no question that she does not rise with reference to the plane of reference. But in the boat it is very clearly evident that the water passing her sides in motion is a very considerable distance below the same water when the boat is at rest. I should say, from my experience in the *Vingt-et-un*, that this difference is fully 4 to 5 inches, at full speed, as a mean difference in the level of the water passing the vessel, and, as Col. Stevens says, there is no other way in which we can account for the low rate at which the resistance increases. The variation for resistance, after 14 knots is reached, is as the 1.43 power, and we all know that the variation of skin surface, as determined by Mr. Froude, is as 1.83 power; consequently, the total resistance is varying at a less power than the wetted surface.

As far as the horse power is concerned, I fear I did not make the matter plain. The brake horse power curve, which we made with the motor, was with the carburator wide open, giving all the gas to the cylinders which they would take, and slowing the motor by adding weight to the brake. The steadily rising horse-power revolution curve rises almost at a straight line up to the point where the gases begin to wire-draw, as we should say in steam practice. Then the cylinder is not getting the full pull; and we reach a point where the power ceases to increase with that particular size of valve. In the case of the *Vingt-et-un* that point was 1,000 revolutions. In estimating the resistance below 68 horse power, and from the resistance the horse power record, we made an assumption on the work done on the screw. We knew from our screw experience that at certain revolutions the variation would be in a certain way, and we varied our resistance from our screw and worked back from that data to the horse power curve. The horse power curve exhibited at one point was not taken from the brake test, as you can see by looking at the paper.

As far as the piston speed is concerned, I know an occasion where this has been run up to 1,200, but the difficulties of ignition and other difficulties greatly increase with the higher speed. I think, however, we can look forward to reaching at least as high piston speeds as we obtain in steam practice.

A MEMBER: What position of the spark flash was used when the test was made?

MR. CRANE: The spark was varied at each tests. We found by experiment the highest point for a given revolution. As far as the towing models are concerned there was an experiment made last winter by the Napier firm. They towed from a 25-knot torpedo boat a series of models, and decided on one. The results from the boat did not bear out the results from the test. The behavior of this particular boat in a sea way, when she was not supported by the towing rope, was most atrocious.

As far as the steering qualities are concerned, the *Vingt-et-un* had no skeg whatever, as you notice. I have handled her many times in a heavy sea, particularly running with a heavy sea quartering, which is certainly the most trying position for a high-speed boat, and at no time have we had to slow the boat owing to yawing. The stern is not flat, but the dead rise carries directly aft, which, I think, has a very large influence on the steering qualities, together with the other shape.

As far as the resistance varying with the different positions of the wave crest is concerned, that is a thing which, I think, all of us can speculate about and very few of us can determine. We know that at certain speeds there are certain variations in the speed curve, and we can determine those points by actual experiment. And that is the important thing for us to know in making further designs. Turning to the resistance curve, we found in the variation that the point of change was practically the same relative point as in the various torpedo boats, and that the point of constant variation began at the same general point. The interesting thing to me was that from 14 knots up there was no further hump in the resistance curve, and that after the wave series had passed the stern the boat was going on at a perfectly steady increase of resistance.

Mr. Packard: It is very hard for me to explain just what I did mean by the up-hill resistance without a long discussion. A simple illustration is a boat towing a tender. When the tender is on the crest of the wave, or just in front of it, it will shoot ahead; when it is on the back of the crest it will slide down hill, until it comes to the next crest behind, when it will shoot ahead and then yaw around. This is done by small boats in a heavy sea. When the wave speed is about the same as that of the boats they will run down hill until they get on the back of the next wave, and they will stay there pending the slide back, and if the wave overtakes them they will shoot ahead again. This same effect seems to be due to the boat itself that creates the wave, when she is moving at the same speed as the wave. It is a complicated problem, but the more I study it the more I am convinced that this is the explanation of the small resistance of the high-speed boats. The change of trim due to the impact of the water has nothing to do with it. It is the actual shape of the water about the boat, that is, whether it is inclined or whether it is horizontal. That the boat does not need to change her trim greatly in the high-speed boats I think is evidenced by the photographs in my paper.

The President: There remain only two papers to be read, and it is suggested as both of these papers are rather in the nature of records of data than subjects for argument they be printed in the transactions without reading.

RECENT LAUNCHING PRACTICE OF THE ATLANTIC COAST.

BY ASSISTANT NAVAL CONSTRUCTOR R. H. M. ROBINSON, U. S. N., MEMBER.

ABSTRACT.

The author of this paper has compiled a great amount of data on the recent launches of battleships from Atlantic coast ship yards. As it came time to launch the battleship *Connecticut* from the navy yard, New York, it was desirable to obtain data as to the best practice in launching similar ships at private yards, and hence a careful investigation was made of this practice. The data ascertained, together with that of the *Connecticut* launch, are given in the paper. A set of interesting curves of velocity, the distance run, acceleration and friction coefficients plotted to time intervals, is appended to the paper. The special features in the launch of the *Connecticut* were the use of four dog shores as a prevention to creeping after the removal of the shores and blocks; a mask for checking the speed of the ship after afloat, and sand bags used for replacing some of the forward keel blocks.

RECENT LAUNCHING PRACTICE OF THE PACIFIC COAST.

BY EVERETT P. LESLEY, ESQ., JUNIOR.

ABSTRACT.

This paper, like the preceding, is a compilation of valuable launching data, and gives the practice on the Pacific coast, as indicated by the launch of the three cruisers, *California, South Dakota, Milwaukee,* built by the Union Iron Works. A detailed drawing is presented of the launching cradle for the *California,* and deserves special attention, first in the character of the support for the ground ways; second, the arrangement of crushing timbers under the fore poppet; and third, the releasing device. Where elevated, the ground ways are supported on A-frame structure. As a result of three crushing tests with Oregon pine, with the grain at three angles with the line of thrust, the fore poppet was so designed that when the stern lifted the crushing stress on the timbers, and, therefore, the weight per square foot on the plating and framing of the hull, did not exceed certain safe limits. The releasing device consists of a weighted car running on an inclined track; when the car is released from the launching platform it strikes and knocks out the trip shore which in turn releases the dog shore.

On Friday evening the annual banquet was held, with addresses by Secretary of the Navy Morton, Police Commissioner McAdoo, and others.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of November 10, 1904, the following degree of completion of vessels building for the United States Navy:

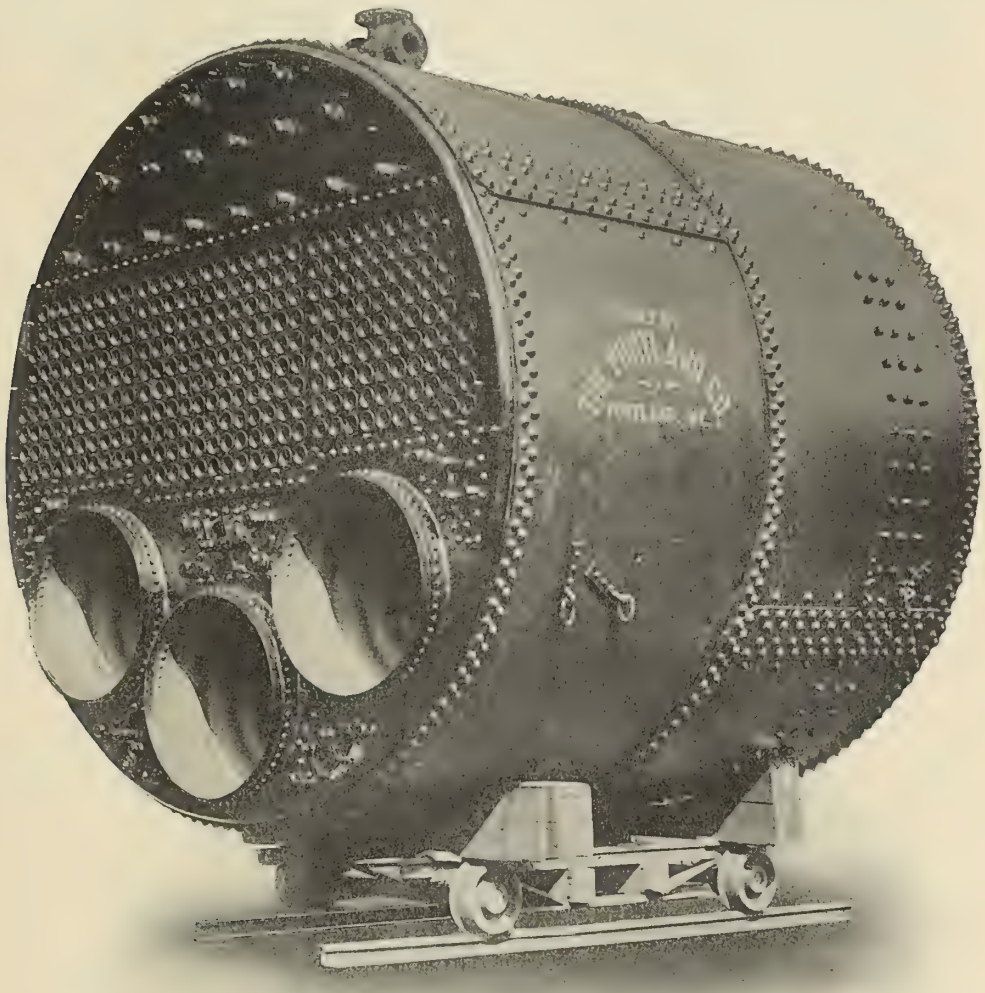
				Degree of Completion. Per Cent.	
BATTLESHIPS.				Oct. 1.	Nov. 1
Ohio	18 knots.	Union Iron Works		99.7	100
Virginia	19 "	Newport News Co.		68.6	71.21
Nebraska	19 "	Moran Brothers Co.		59	61.4
Georgia	19 "	Bath Iron Works		65.3	67.47
New Jersey	19 "	Fore River S. and E. Co.		69.1	70.7
Rhode Island	19 "	Fore River S. and E. Co.		71.2	73.5
Connecticut	18 "	Navy Yard, New York, N. Y.		53.59	56.4
Louisiana	18 "	Newport News Co.		59.68	61.5
Vermont	18 "	Fore River S. and E. Co.		21.5	25.8
Kansas	18 "	New York Shipbuilding Co.		26.6	31.2
Minnesota	18 "	Newport News Co		43.8	46.56
Mississippi	17 "	Wm. Cramp and Sons		10.24	11.89
Idaho	17 "	Wm. Cramp and Sons		9.98	10.61
ARMORED CRUISERS.					
Pennsylvania	22 knots.	William Cramp and Sons		90.5	94.79
West Virginia	22 "	Newport News Co.		94.2	95.5
California	22 "	Union Iron Works		64	65
Colorado	22 "	William Cramp and Sons		95	97.11
Maryland	22 "	Newport News Co		90.57	92.16
South Dakota	22 "	Union Iron Works		61.5	63
Tennessee	22 "	William Cramp and Sons		50.06	54.85
Washington	22 "	New York S. B. Co.		44.7	50.2
PROTECTED CRUISERS.					
Chattanooga	16½ kts.	Lewis Nixon		97	97
Galveston	16½ "	Wm. R. Trigg Co.		91	94
St. Louis	22 "	Neafie and Levy Co.		51.1	54
Milwaukee	22 "	Union Iron Works		58.5	60
Charleston	22 "	Newport News Co.		83.2	84.34
GUNBOATS.					
Dubuque	12 knots.	Gas Engine and Power Co.		63.9	68.2
Paducah	12 "	Gas Engine and Power Co.		58.9	64.9
TRAINING SHIPS.					
Cumberland	Sails	Navy Yard, Boston		72	80
Intrepid	"	Navy Yard, Mare Island		56.2	63
TRAINING BRIG.					
Boxer	Sails	Navy Yard, Portsmouth		85	90
TORPEDO BOATS.					
Stringham	30 knots.	Harlan and Hollingsworth		99	99
Goldsborough	30 "	Wolff and Zwicker		99	99
Blakely	26 "	George Lawley and Son		99	99
Nicholson	26 "	Lewis Nixon		99	99
O'Brien	26 "	Lewis Nixon		98	98

MACHINERY OF THE NEW UNITED STATES HARBOR DREDGE KEY WEST.

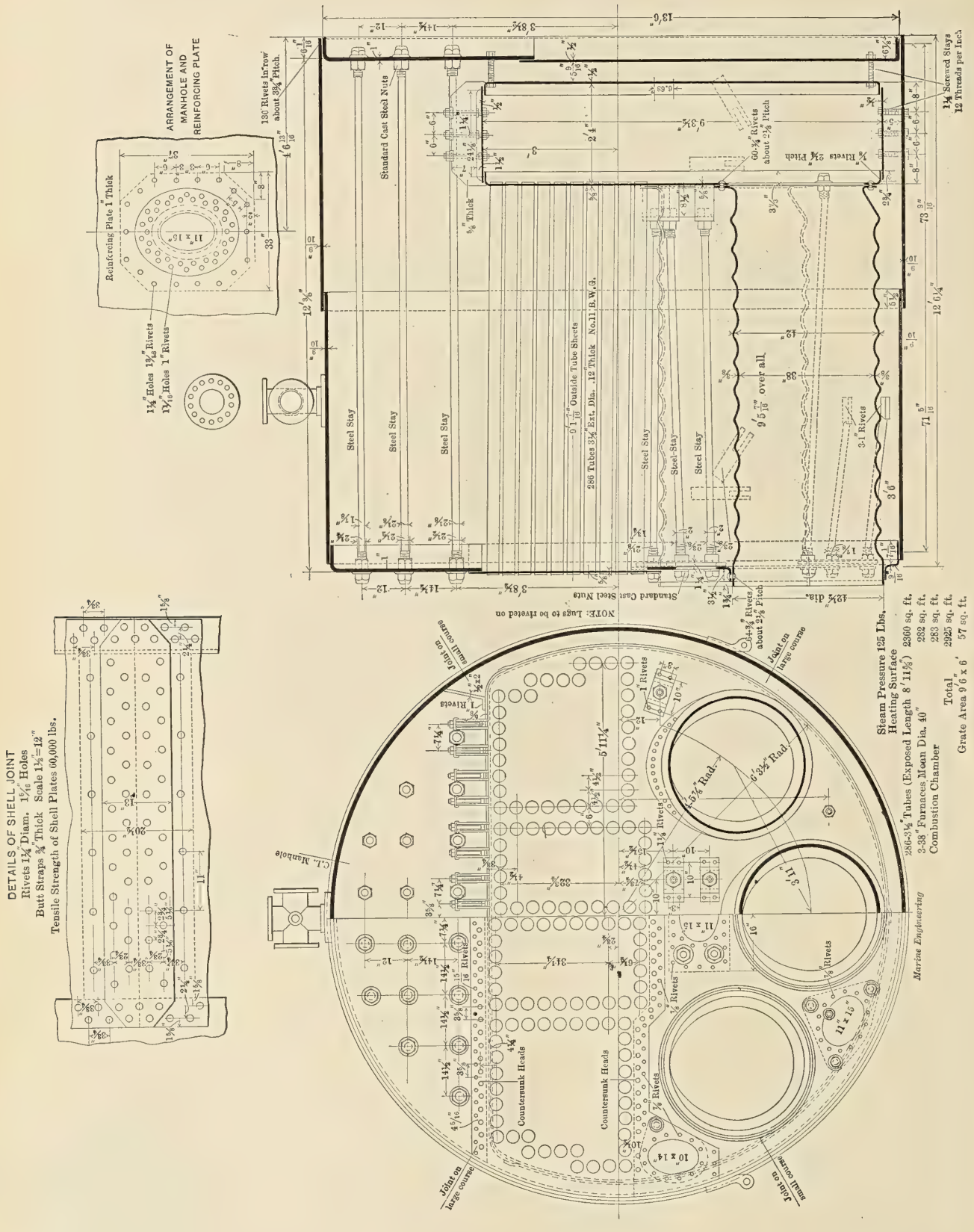
A very strong, wooden dredge has recently been completed at the Portland Company, of Portland, Me., for the United States army, from specifications prepared by J. C. Sanford, Captain of Engineers, United States Engineer Office, Philadelphia. The dimensions of the hull are given on the data card, and the scantlings of a few of the members will serve to show how heavily this dredge is timbered.

Keel, oak, 12 by 12 inches; stem, 12 by 12 inches, oak; apron, 12 by 12 inches, oak; stern post, 12 inches sided; rudder post, oak, sided 12 inches, molded 14 inches. The frames are of hard wood, spaced 24 inches centers, doubled to mold 12 inches at the keel and 6 inches at the rail. The deck beams are of Georgia pine 12 inches sided, molded 12 inches at center and 7 inches at ends, while those beams at the ends of bins are to side 6 inches. Planking, Georgia pine, 4 inches thick on sides, 3 inches on bottom. There are two bins, one forward and one aft.

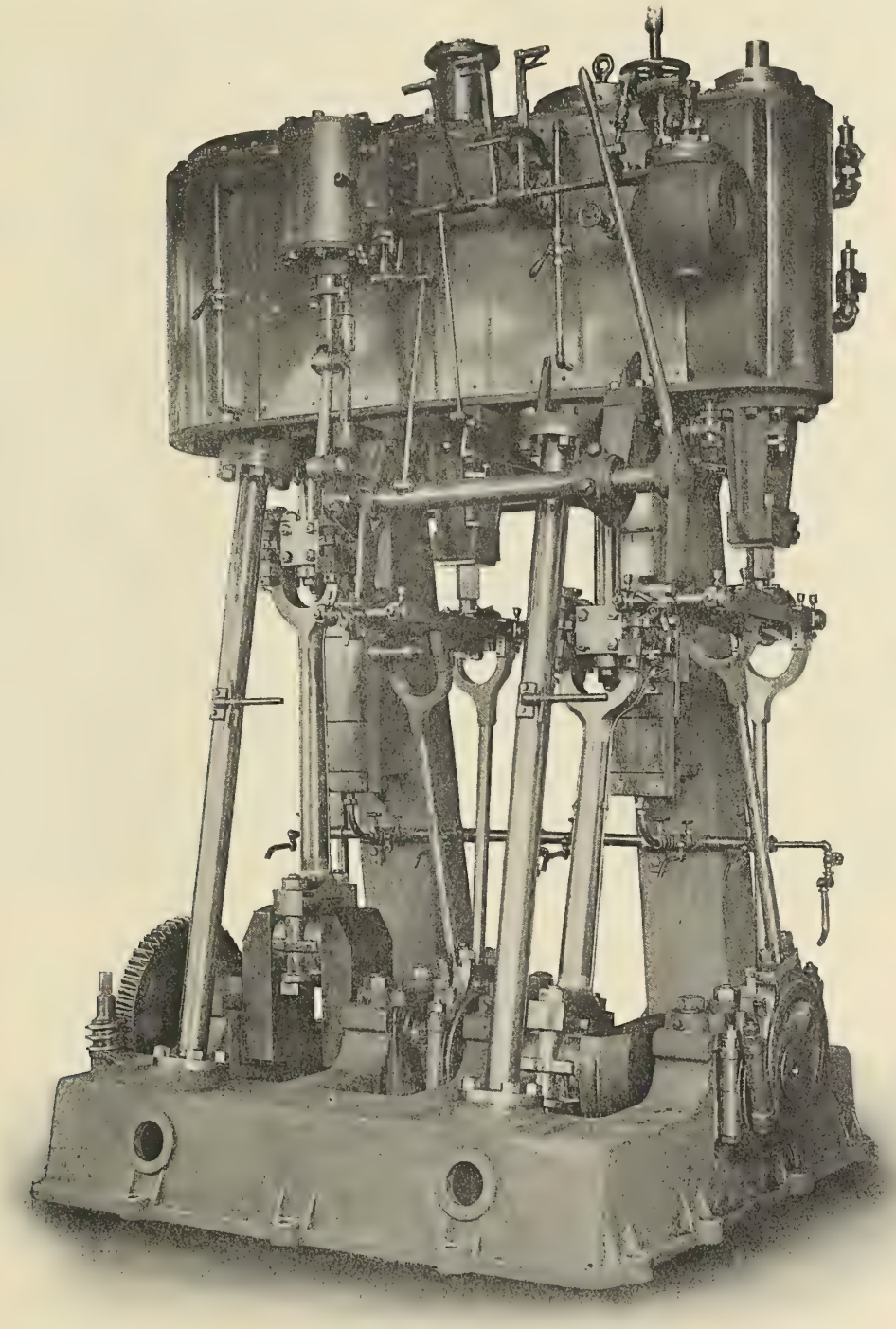
The propeller engine consists of a set of compound condensing engines, with cylinders 17 and 32 inches diameter and 24 inches stroke. The general arrangement of these engines is shown in the accompanying drawing, and is of the open-frame slipper-guide type, with turned columns at the front. Steam and hand reversing gears are fitted, as clearly illustrated in the engraving on page 575. The valves are operated by the Stevenson double link motion, and consist of a piston valve on a high-pressure and a double-ported slide on a low-pressure cylinder. The shafting is forged steel 7 1-2 inches diameter. A cast iron propeller, 7 feet 8 inches diameter by 12 feet pitch and with four blades, is fitted to the tail shaft. A separate plate shell condenser with 1,000 feet of cooling surface is fitted with 5-8 inch solid drawn tinned tubes. The air pump is double acting vertical type with a 7-inch diameter steam cylinder, 12-inch diameter air cylinders by 10-inch stroke.



SCOTCH BOILER FOR THE UNITED STATES HARBOR DREDGE KEY WEST.


ARRANGEMENT OF MANHOLE AND REINFORCING PLATE
Reinfreing Plate 1" Thick
11" x 15"
1¾" Holes 1⅝" Rivets
1⅞" Holes 1" Rivets
136 Rivets in row about 3¾" Pitch.
Standard Cast Steel Nuts
Steel Stay
Steel Stay
Steel Stay
Steel Stay
Steel Stay
Steel Stay
Outside Tube Sheets
286 Tubes 3¾" Ext. Dia. .12" Thick No.11 B.W.G.
60-¾" Rivets about 2⅛" Pitch
¾" Rivets 2¾" Pitch
3-1" Rivets
9' 5 7/16" over all
Screwed Stays 12 Threads per Inch
NOTE. Lugs to be riveted on
Standard Cast Steel Nuts
64-¾" Rivets about 2⅛" Pitch
Joint on small course
Joint on large course
Manhole
Countersunk Heads
Countersunk Heads
Joint on large course
Joint on small course
Steam Pressure 125 Lbs.
Heating Surface
286-3¼" Tubes (Exposed Length 8' 11½") 2360 sq. ft.
3-38" Furnaces Mean Dia. 40" 282 sq. ft.
Combustion Chamber 283 sq. ft.
Total 2925 sq. ft.
Grate Area 9'6" x 6' 57 sq. ft.
DETAILS OF SHELL JOINT
Rivets 1¾" Diam. 1 5/16" Holes
Butt Straps ¾" Thick Scale 1½=12"
Tensile Strength of Shell Plates 60,000 lbs.
Marine Engineering
DETAIL DRAWINGS OF THE KEY WEST BOILER, BUILT BY THE PORTLAND COMPANY.

The auxiliaries include the usual equipment of circulating, feed, sanitary, and fire pumps, injector, siphons and feed water heater. There is one Scotch boiler installed, 13 feet 6 inches diameter by 12 feet long, illustrated on preceding pages. This is fitted with three Morrison furnaces connecting to one combustion chamber; the total heating surface is 2,925 square feet and the total grate surface, with 6-feet bars, 57 square feet. The boiler is designed for 125 pounds pressure. The vertical donkey boiler, 42 inches diameter and 8 feet 3 inches high, is built to stand a working pressure of 125 pounds.



COMPOUND PROPELLING ENGINE OF THE UNITED STATES HARBOR DREDGE KEY WEST.

The pumping engine consists of a direct-connected, compound condensing engine, with cylinders 12 and 22 inches by 14 inches. The high-pressure is fitted with a piston valve and the low-pressure with a slide valve.

The 15-inch, centrifugal type pump of extra heavy construction is specially adapted for dredging. The runner is designed for from 200 to 250 revolutions per minute, and is capable of raising and discharging against a total head of 14 feet, 60 cubic yards of water per minute. The pumping equipment includes the customary suction pipes, which are 15 inches diameter, and discharges to the forward and after hoppers, apparatus for raising of lowering suction pipe, etc. The vessel is lighted throughout by electricity. The trials, which were recently carried on at Portland, resulted satisfactorily.

Making a Nut at Sea.

During a voyage to South America some fifteen years ago, the square thread nut in the ram of the lubricator gave out. The nut was six threads per inch. We had no dies or taps to cut a square thread, but as I was second engineer it was my duty to repair it. My first plan was to run a nut of babbit metal, but owing to the excessive pressure this ran only about three hours, and of course I was subjected to the usual amount of guying for its failure. This put me on my mettle—in more ways than one. I took two pieces of pine and dowelled

VIEW OF THE SUCTION HARBOR DREDGE KEY WEST, TAKEN DURING DOCK TRIAL.

MARINE ENGINEERING DATA CARD. DECEMBER, 1904.

NAME—Key West. NATIONALITY—American. TYPE—Harbor suction dredge.

LAUNCHED—1904. BUILDER—Portland Co. OWNER—U. S. Army.

Length over all.....141 ft.
" between perps.....130 "
Beam, molded.....31 "
Depth, " .....15 "
2 sand bins—1 forward, 1 aft.

Propelling Machinery:
Type of engine (one).....compound
Cylinders.....17, 32 ins. by 24 ins.
Shafts, diameter.....7 1-2 "
Condenser, surface.....1 000 sq ft.
Air pump, indep.....(1) 7, (2) 12 by 10 ins.

Propeller:.....4 blades, cast iron
Diameter.....7 ft. 8 ins.
Pitch.....12 " 0 "

Boiler:.....one Scotch
Steam pressure.....125 lbs.
Diameter.....13 ft. 6 ins.
Length.....12 " 0 "
Tubes (286).....3 1-2 ins. by 9 ft. 1 7-16 "
Furnaces (3).....38 "
Grates.....6 ft.
H. S.....2,925 sq. ft.
G. S.....57 " "
Donkey boiler..vert. 42 ins. by 8 1-4 ft., 125 lbs.

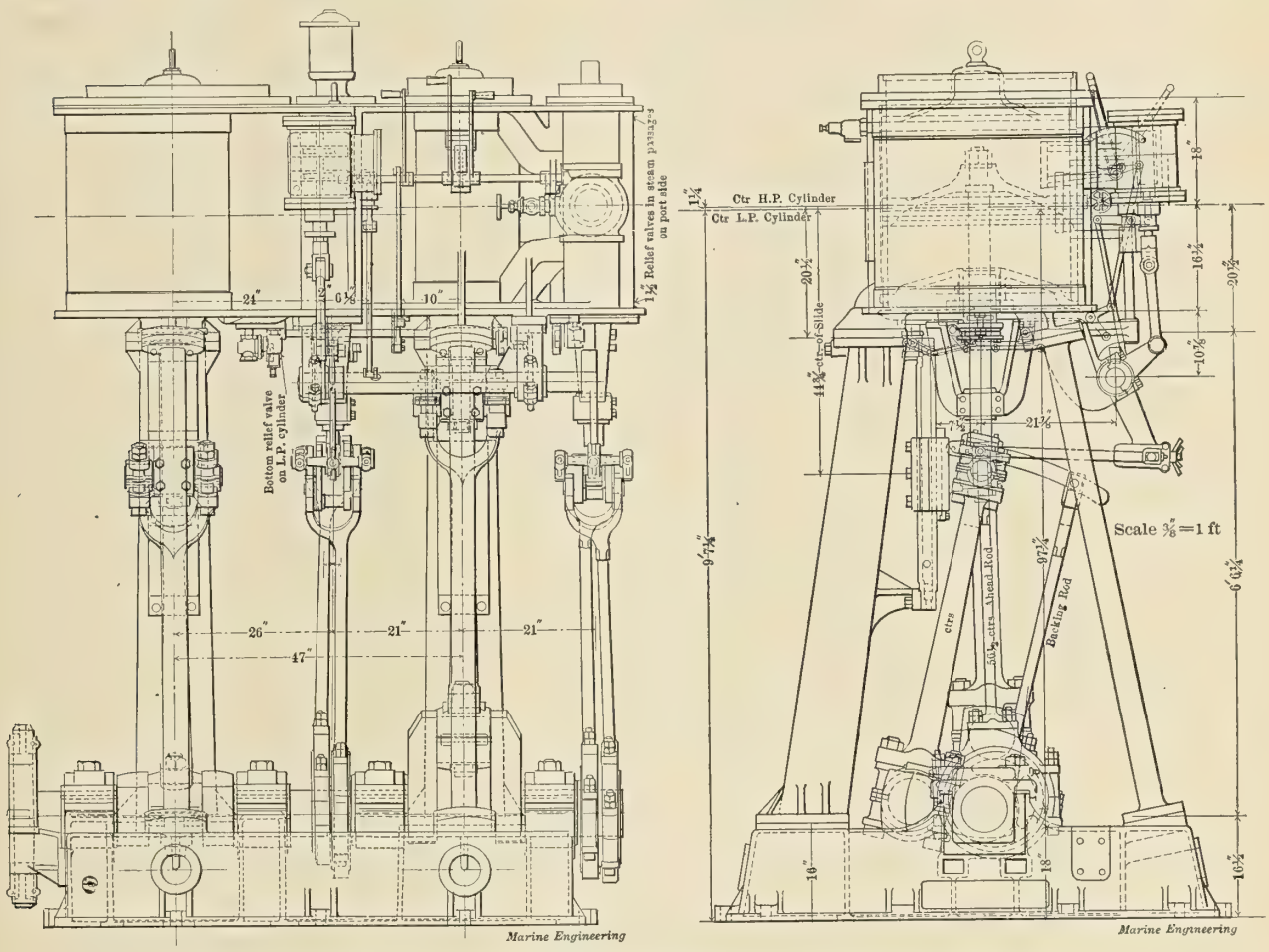
Dredging Machinery:
Engine.....one compound
Cylinders.....12 and 22 ins. by 14 ins.
Pump.....centrifugal sand, 15 "
R. P. M.....200–250
Capacity against 14 ft head, 60 cubic yards water per minute.

them together, heated the square thread screw and squeezed it between the two pieces of wood held in the vise, at the same time rotating the screw. This gave me a very fair core box. I then made a crucible of fire clay—used for repairing furnace bridges—made a core of fire clay, and finally a mold of the same material.

This time I melted some scrap brass in my crucible and cast it in the fire clay mold. The result was a fairly good square thread nut which lasted about four months, and when taken out to be replaced it was found to be hardly worn at all. E. A. SUVERKROP.

FREEBOARD.

Freeboard, as applied to vessels of the mercantile marine, being a subject of general interest to those engaged in the shipping trade, it is believed that a few of the details connected with its origin and subsequent official application in Great Britain as one of the means to prevent overloading, and consequent disasters at sea from such causes, will be appreciated. The following clause, which is to be found in a United States government circular letter, dated Washington, March 5, 1891, is the only indication in our shipping laws as to how



GENERAL ARRANGEMENT DRAWING OF THE PROPELLING ENGINES OF THE SUCTION DREDGE KEY WEST.

Wireless Telegraphy on Great Lakes.—When the season of 1905 opens on the Great Lakes it is expected that 10 wireless telegraph stations will be in operation. Four stations have already been placed in commission and six others are being erected or arranged for. This number is sufficient to keep a steamer equipped with wireless apparatus in touch with the shore from St. Louis to Duluth or Chicago. With this apparatus, which is of the DeForest system, a vessel may receive storm warnings and be in telegraphic communication with her owners during the entire trip, and her destination may be changed to avoid placing cargo in a glutted market. The saving of lives and property as well as giving better despatch to the vessel will doubtless result.

such freeboard or load line should be determined: "Section 2. . . . The owners, agent, or master of every inspected sea-going steam . . . vessel shall indicate the draft of water at which he shall deem his vessel safe to be loaded for the trade she is engaged in, which limit, as indicated, shall be stated in the vessel's certificate of inspection, and it shall be unlawful for such vessel to be loaded deeper than stated in said certificate." A limit to such load line, based on the depth of hold, but on that alone, is to be found further on as a complement to the circular in question.

The word "freeboard" denotes the height of platform, or, in other words, the height of the side of the ship above the water line at the middle of her length measured

from the top of the deck at side; or, in cases where a water way is fitted, from the curved line of the top of the deck ending on the plank next to the water way and continued through to the side, at which point of intersection it becomes what is known as the "statutory deck line;" the corresponding draft of water of the vessel with the freeboard assigned as above is the "load line."

In January, 1884, the British government appointed a royal committee to inquire and report upon the best means whereby a suitable load line might be assigned to vessels engaged in the ocean trade, and, about five years later, on the recommendation made by its commissioners, among whom we find the names of such eminent naval architects and shipbuilders as the late E. J. Reed, William Denny, Robert Duncan, Francis Elgar, Thomas Gray, B. Martell, and others, that government adopted a law making it compulsory for every British vessel to have a load line based on the freeboard tables already adopted by Lloyd's Register of Shipping, said load line to be assigned under the control of the Board of Trade. Up till that date, viz., 1890, the application of the freeboard tables adopted by Lloyd's committee was optional, except with reference to the classification of certain types of vessels, including those known as awning or shelter-deck ships, in which considerations of strength made it incumbent to limit the draft of water to a maximum; but, after the year 1890, and irrespective of the rules published by any of the recognized societies of classification, no vessel was allowed to leave port without a freeboard having first been assigned to her; and, although certain modifications have, from time to time, been made at the suggestion of the Board of Trade, or with their approval, to meet the requirement of some specific cases, this principle of the application of a maximum load line has been adhered to ever since.

Nearly fifteen years have elapsed since that law was promulgated in Great Britain, and, that country being still in the lead in matters appertaining to shipping in general, it is not surprising to find that although no other maritime country appears to have seen fit to enact similar regulations of its own, yet most of them have, unofficially at least, adopted the same rules, possibly because it was felt that none better could conveniently be devised. This, however, does not mean that no attempt has ever been made in that direction, and the writer is aware that in other countries, both in government and other circles, the question of assigning a load line has been raised. Unfortunately, it may be said, no conclusion appears to have been reached, owing chiefly to the opposition vouchsafed by a majority of influential ship owners, who, rightly or wrongly, fear the interference of governmental legislation and the possible prejudice any recognized limit placed upon the loading of their vessel might cause to their trade already hampered by so many other burdens.

There can be no question but that, apart from all other considerations, that of the safety of human life at sea is one of the greatest responsibility. This remark does not apply to the officers and crew of first-class transatlantic liners whereon everything that science, experience, and money can suggest and obtain has been devised for the safety and comfort of the passengers who avail themselves of this means of transportation; but, there are others, and not less deserving ones, whose devotion to duty under much less favorable conditions are also worthy of being cared for, and whose lives should be protected against any attempt to abuse the present indefinite state of the law in relation to the limit which should be placed upon the loading of ships. First-class vessels may be built and their general construction and scantlings may be such as to insure absolute seaworthiness against the elements under almost any circumstances. But, in every ocean-going craft, no matter how well designed, there enters a question of stability, the effectiveness of which depends largely upon the nature and disposition of the cargo. There also enters a very serious question of reserved buoyancy, the percentage of which as compared with the total volume displaced, materially affects the ability of the vessel to raise and recover herself from a succession of heavy seas shipped during a storm. If, then, such vessel be laden beyond the limit of safety, she may founder, and, like many others whose fate has never been definitely ascertained, may disappear with all on board, leaving only the widows and orphans to mourn the loss of the braves, who, for the sake of their reputation as sea-faring men, and a miserable pittance regulated by the universal law of supply and demand, were induced to risk their lives rather than shirk the responsibilities thrust upon them by the ignorance of some and the indifference of others.

A mere contemplation of the possibilities of loss of life at sea through the overloading of ships in general, would seem to call imperatively for some legislation on the subject; and, it appears almost incomprehensible at first sight that the example set by Great Britain in that respect has not been followed sooner by other maritime powers whose humanitarian principles are known to be identical. Therefore, it may perhaps fairly be assumed that whilst recognizing the desirability of enacting some uniform law susceptible of coping with the subject as a whole, other governments have met with much difficulty in trying to reconcile the various interests at stake as well as much diversity of opinion as to the technical merits of the present freeboard tables, which, owing to their actual standing, would naturally be taken as a basis for legislation.

It is not proposed to enter into the commercial aspect of the case, first, because we have no right to assume that any ship owner in this country would willfully send his vessels out to sea knowing them to be in an unseaworthy condition; and, secondly, because it is more within our province to deal with this question from a purely scientific and technical point of view.

The freeboard tables, to which reference has already been made, and which were included in the act of parliament adopted by Great Britain in 1890, were evidently of a tentative nature; and, although they may be said to have "held their own" until the present time, with what must be admitted as fairly good results all round, it will be sufficient for one to read the load-line committee's report, presented by the commissioners to the then president of the Board of Trade, to be convinced of that fact. The commissioners, even after availing themselves during a period of from four to five years of all the evidence placed at their disposal by ship owners, ship builders, masters, and others connected with the mer-

cantile marine, do not hesitate to admit that "a large discretion must be allowed to responsible authorities in applying the tables themselves with reasonable modifications to any very exceptional vessels which may now exist or may hereafter be constructed." They also "admit that undue interference with trade might occasionally arise were the tables to be applied henceforth to all ships, present and future, without any exception whatever." And, having thus exonerated their conscience by declining future responsibility, they deliberately adopted, with a few modifications to meet existing statutes which could not conveniently be repealed, the tables which Lloyd's Register of Shipping had been nursing and modifying about ten years, in the hope that by dint of repeated concessions the ship owners would see fit to accept them.

To clearly understand this it is necessary to go back to the eighties, when, succeeding to what was then known as the "Plimsol agitation," innumerable suggestions were made with the object of checking the scandalous loss of life due chiefly to the overloading of ships, many of which, however, were not even seaworthy, whether overladen or not. The late Mr. Plimsol undoubtedly deserves much credit for the improvements which may be said to have been almost directly due to the efforts he made in favor of the cause he so valiantly upheld, but it is quite possible that, like other leaders of an otherwise worthy cause, he was, through political influences, led into errors and exaggerations which his lack of technical knowledge did not enable him to fully appreciate.

The immediate result of the Plimsol agitation was that a load line was considered imperative; but, as there were practically no rules in existence for determining the position of that load line, to every ship owner was left the responsibility of fixing the draft of water which he declared he would not exceed in navigating his vessel. This elementary method of apparently settling the question, and which, after all, does not differ materially with present conditions in the United States, sometimes gave rise to peculiar misconceptions. While it is readily admitted that the majority of ship owners were, in such cases, guided by the result of their experience of the particular vessel to which such load line was to be applied, yet the writer knows of cases in which the Plimsol mark, as it was then called, was deliberately placed a foot or more higher up than could be considered suitable for the safe navigation of the ship, merely for the sake of the moral effect this exhibition would have upon the simple-minded sailor, whose satisfaction was complete so long as the Plimsol mark was *not under water.*

This, as also the differences of opinions constantly arising with reference to a suitable load line for any given vessel, made it almost a matter of necessity that some uniform rule should be adopted, and the question arose as to the most equitable basis for such rule or regulation. An old-fashioned method still much appreciated by some of our "ancient mariners," was to calculate the freeboard by an allowance of so many inches (say 2 to 3 1-2 inches) for every foot depth of hold; but, whilst this ready means of determining freeboard might have applied to vessels whose proportions of depth to length were of the usual kind as built some sixty years ago, it was quite evident that its general application in modern times would and did lead to the construction of long and shallow vessels whose extreme proportions in that respect were a source of structural weakness.

Moreover, it was felt that with the ever-increasing size of ships, as well as in consideration of the various types constantly devised to meet the requirements of the particular trade in which they were engaged, it was essential that, as far as practicable, each type, and even each vessel, should be dealt with upon her own merit; also, as science had materially helped in determining the strains to which such vessels are liable in a sea way, it was natural that science, coupled with the results of practical experience, should be called upon to determine the maximum draft of water suitable in each case, seeing that as a fundamental principle and apart from other considerations it is now universally recognized that strains in ships vary in proportion to their displacement and the effective sectional area of the material of which they are built. Hence the investigations started by a number of prominent men which resulted in voluminous interesting statistics supplied by various classification societies and others, with a view to providing sufficient data for the purpose and with the object of exchanging views as to the best methods to be employed.

The commissioners' report was unanimous in arriving at the results obtained, but, in dealing with this, as in the well-known case of the patient when doctors disagreed, each of the several parties in search of a remedy for the evil from which the mercantile marine was suffering, was prone to suggest a method of his own which did not altogether meet with the approval of the others. Some believed in one thing and some in another. One was of the opinion that the "height of platform" was of paramount importance, and others pinned their faith on the "reserved buoyancy."

In connection with this latter point it may be well to recall the investigations, also the results obtained and published by the late Liverpool Underwriters' Registry, at the head of which was Mr. Henry H. West, whom many will remember as one of the most genial of his kind. The report did not profess to fix a hard and fast line, but simply to offer some information for the guidance of ship owners and underwriters by indicating (with a corresponding draft of water to each) the various percentages of reserve buoyancy, viz.: 20, 25, 30, and 35 per cent. of such total value as had been assessed by a certain formula, leaving the ship owners to use their own judgment as to the approximately correct amount of reserve buoyancy which should be retained to insure safe navigation.

By this method of assessment a line was drawn parallel to the keel at the height of the molded depth at side at the lowest point in the sheer and the external displacement of this portion of the vessel was set down as the principal item to which were subsequently added:

Displacement due to the sheer of the vessel,
" " " " round of beam, and,
" " " " thickness of the deck;

the whole, representing strictly the main structural parts of the ship, being reduced to tons of 100 cubic feet for the sake of convenience in dealing with the figures.

The next item dealt with the erections or superstructures on the deck proper; and, after taking into consideration their extent, height, and efficiency from a structural point of view, each was gradually but systematically reduced by means of ratios until their estimated intrinsic value bore a proportion which seldom exceeded 40 per cent. of their actual displacement. This process of assessing the value of erections was a delicate one no doubt, and, although it may be said to have had the merit of being uniform throughout, its weakness laid in the fact that it was based on an arbitrary rule. The same remark may be applied to that portion of the present freeboard tables relating to erections on deck; and a reference to the *Explanatory Notes on the Application of the Freeboard Tables*, issued by the British Board of Trade, only serves to intensify the complexity of those tables and to additionally prove the difficulties which were met with in dealing with this important question.

One thing, however, appears to be certain, viz., that the arguments in favor of reserve buoyancy as a primary factor were sound; and that although an absolutely correct method of determining its proportions for every vessel is admittedly not provided for in the tables under discussion, yet the principle has been recognized and a rule has been devised to approximate its relation to the total volume below water. How far that object has been attained is extremely doubtful. The approximate method given by the Board of Trade to represent the displacements up to and including the upper surface of the tonnage deck is based upon the coefficient of fineness; but, inasmuch as said coefficient is one of *internal* instead of *external* capacity, it is easy to understand how errors may unconsciously be introduced into the very basis on which the whole fabric is constructed.

True it is, experience has shown that a fairly constant relation exists between the internal and external capacity, the latter being about 1.15 or 1.17 to 1; but this only applies to vessels built on the ordinary transverse systems, with frames and floors of normal dimensions, and although it is equally true that the tables, in their numerous exceptions as well as in the appendix, contemplate modifications intended to equalize deviations from the ordinary routine, the fact remains that the registered tonnage under deck which plays so important a part in these calculations cannot always be relied upon otherwise than being an official record the strict accuracy of which is seldom if ever challenged on account of its official source. There are many known instances wherein the actual coefficient, as intended for use in the freeboard tables, comes well above .82, which is the maximum percentage indicated in said tables; and as this coefficient should represent accurately the fineness or fullness of form of any given vessel, it follows that if neglected it fails to take into proper consideration one of the principles on which the tables are based. Moreover, these tables, treating this as a block coefficient, do not take into consideration the important fact that such ratio of the whole to the cube of the three principal dimensions, viz., length, breadth, and depth, represents an average or mean. Vessels, and especially those intended almost exclusively for freight-carrying purposes, differ very materially as to forms; and in cases wherein the shape of the midship frame is carried far into both the fore and after bodies, ending at the stem and stern with very bluff lines, it is evident that the center of gravity of weight (longitudinal center of buoyancy) being carried much beyond its position than would be the case in vessels of relatively finer forms, the increased distance of the center of that weight from the middle of the vessel's length has a tendency to considerably increase the strains which the combined section area of the material amidships was intended to bear with safety.

A careful study of this question, and the result of comparisons made by the writer some fifteen years ago on more than two hundred vessels of various types, demonstrated that, assuming a series of ships having precisely the same dimensions and with the same rise of floors, a difference of close upon 16 1-2 per cent. could be obtained in their displacement by modifying the lines without altering the midship section; and that being the case, it follows that, according to Lloyd's Rules, whose scantlings are regulated by the addition of the 1-2 girth of the midship frame, the 1-2 beam and the depth, multiplied by the length of the vessel in feet and fractions thereof, any of these vessels when built would present exactly the same aspect as to their capabilities to resist the shearing and hogging strains to which they may be liable in a heavy sea, without reference to "form," although it is evident that the fuller ships when laden, especially with a dead-weight cargo, would suffer most.

It also follows that if the scantlings, as regulated by the above-named rules, are adequate for the fuller ships, they are excessive for the finer ones which are thus unnecessarily penalized by an additional weight of material detrimental to their carrying capacity. On the whole it shows that, in taking a coefficient of fineness as a basis for determining the form of a vessel, it is also necessary to ascertain the position of the longitudinal center of buoyancy relatively to the middle of the vessel's length, as this will affect the efficiency of the sectional area of the material upon which the whole structure depends and which was taken as a standard of strength in framing the tables. This does not appear to have been done, and if it be argued that the coefficient of fineness for freeboard purposes is chiefly intended as a means of approximating the forms of a vessel, in order to further approximate her displacements to the height of the deck to which the freeboard is taken, it is submitted that this is not sufficient for practical purposes, inasmuch as the under deck tonnage of modern built steamers cannot be said to represent a constant relation to their external capacity, and also because said coefficient fails to include in its scope the relative position of weights which control the longitudinal strains to which a ship is liable.

Other items are no doubt opened to criticism also, and it is felt that the considerations which govern the reduction of the original freeboards used in Tables A, B, and D, specially with reference to the superstructures above the tonnage deck, are extremely complicated. Notwithstanding the numerous rules and equally numerous exceptions relating to these, it may be said also that too much latitude is left to the surveyors in determining the percentage of efficiency and corresponding deductions or additions to freeboard which should be made on account of the strength or weakness of these erections; their means of ingress, and the facilities afforded the crew

to enable them to get backwards and forwards from their quarters if not berthed in the bridge house. In other words, it is felt that the present freeboard tables are perhaps unduly complicated for general use and that their application should not be controlled solely, as it is practically at present, by one society's rules, which, however excellent in many respects, are by no means infallible. This absolute recognition of Lloyd's Rules as a permanent standard of structural efficiency for all vessels to which a freeboard may, or must, be assigned to meet certain requirements, is susceptible of placing certain ship owners at a disadvantage, specially when their ships, although quite suitable for the particular service in which they are engaged, do not happen to have been built under the special supervision of the surveyors to Lloyd's Register.

Their existence also had a salutory effect at the time conservative in its views—so much so, indeed, that, tired of the tyranny it exercised for years previous to 1872, the Liverpool ship owners and underwriters founded the *Red Book,* as a check upon its ever increasing demands for more weight. The *Red Book* disappeared in 1885, having been absorbed by its stronger and more wealthy competitor; but the Glasgow builders and owners, fearing a recurrence of their troubles from the monopoly which threatened to again have the upper hand, brought forth the British Corporation, in whose register a good many Clyde-built vessels are classed, as well as several on this side of the Atlantic. The Bureau Veritas, another important international classification society, has held its own ever since 1828, and it must be admitted that the existence of these several societies, outside of Lloyd's Register, has materially contributed to the maintenance of an equitable basis on which ships can be constructed with absolute efficiency and yet without prejudice to either the builders or the owners of the same.

Their existence also had a salutory effect at the time the freeboard tables were framed, for, although Lloyd's tables were adopted officially as a government measure in 1890, they had by that time undergone many modifications in the hope of meeting the severe criticisms to which they gave rise, specially when issued in book form in 1882. A more liberal allowance was made, and under the plea of "adopting a practice ship owners would like to follow," a considerable reduction was made in the freeboards originally published.

All this tends to show that however elaborate the rules for assigning a freeboard as approved by the British Board of Trade may be, their highly scientific clothing covers certain weaknesses which demonstrate that a good deal of the "rule of thumb" had to be resorted to before they could be brought up to their present standard, yet it will no doubt be readily admitted that tentative efforts were most desirable at the beginning and that the complex nature of the problem rendered experiments inevitable. The question now would be to take advantage of the experience gained by the working of the present tables to frame similar ones, or others which might be simplified, and in which the possibility of errors could be eliminated by the adoption of certain rules representing more accurately the various items to be taken into consideration.

It might be impossible, as was found in Great Britain in the case of some vessels actually afloat, to obtain the data requisite for constructing a complete displacement scale from which by deduction the exact ratio of the internal to the external capacity as well as the exact percentage of reserve buoyancy on a given draft of water might be ascertained; and for all such cases previous records of these vessels at sea and the results of practical experience would be sufficient in determining a suitable load line. In the case of either recently built vessels or others under construction where such data is easily accessible, there seems to be no reason why the *external* capacity should not be selected in preference to the tonnage to obtain the coefficient of fineness. This would be strictly accurate, and as the same data employed to arrive at the displacement could be utilized for obtaining the position of the longitudinal center of buoyancy in both the fore and after bodies, this item might be taken into consideration in determining the effect of its position on the probable resistance of the material amidships. Each vessel should be dealt with on her own merits, regardless of the classification society (if any) under whose special supervision she was built, the government adopting standard rules of its own.

Regulations covering the extent, strength, and general efficiency of superstructures for various types of ships should also be made uniform and rigidly enforced, thus reducing to a minimum the discretion of surveyors whose personal opinion might be influenced by local considerations in widely spread districts; and it is believed that if these and probably other suggestions were carefully considered it would not be difficult to arrive at a satisfactory solution of the problem of determining a suitable load line for American-owned ships at least. That a universal load line should prevail for vessels of every nationality is necessary to the interests of shipping in general; both for the sake of the sea-faring community as well as for the protection of ship owners and underwriters, some international congress should be created to deliberate and determine upon the best method on which such load line might be assigned to bring that question on the same level as the tonnage laws.

The necessity of this can be seen at a glance. No vessel, British or otherwise, is allowed to leave a port of the United Kingdom without inspection by a Board of Trade surveyor who may order some of her cargo to be discharged if, in his opinion, that vessel does not comply with the regulations as to freeboard, the same rule applying to the British vessel when leaving a foreign port; but any vessel, if not sailing under the British flag, may return to the same port in what would be considered an overladen condition, or sail from any foreign port with a considerably reduced freeboard and a corresponding increase of dead-weight capacity simply because she is not subject to any definite rule as to a maximum load line. As a single example out of many, a steamer 215 feet long, by 30 feet beam, by 16 feet deep, of about 600 tons net, classed 100 A1 at Lloyd's, sailed repeatedly from Cardiff with coals with a freeboard in accordance with the Board of Trade rules, but when leaving another port (outside the United Kingdom) with sugar or other freight she usually carried between 200 or 300 tons more cargo. Under such circumstances it must be assumed that either the freeboard assigned by the Board of Trade was excessive or that the vessel was sadly overladen; but be that as it may, the fact that vessels of the same

type and same dimensions but of different nationalities may be allowed to load under peculiar conditions must be regarded as a glaring injustice to the owner whose vessel's draft of water is limited by law, while at the same time the excess in the loading of the "free" ship must be a source of danger to the lives of those on board and to the safety of the valuable cargo she may be carrying, if the freeboard tables approved by the British government are of any account.

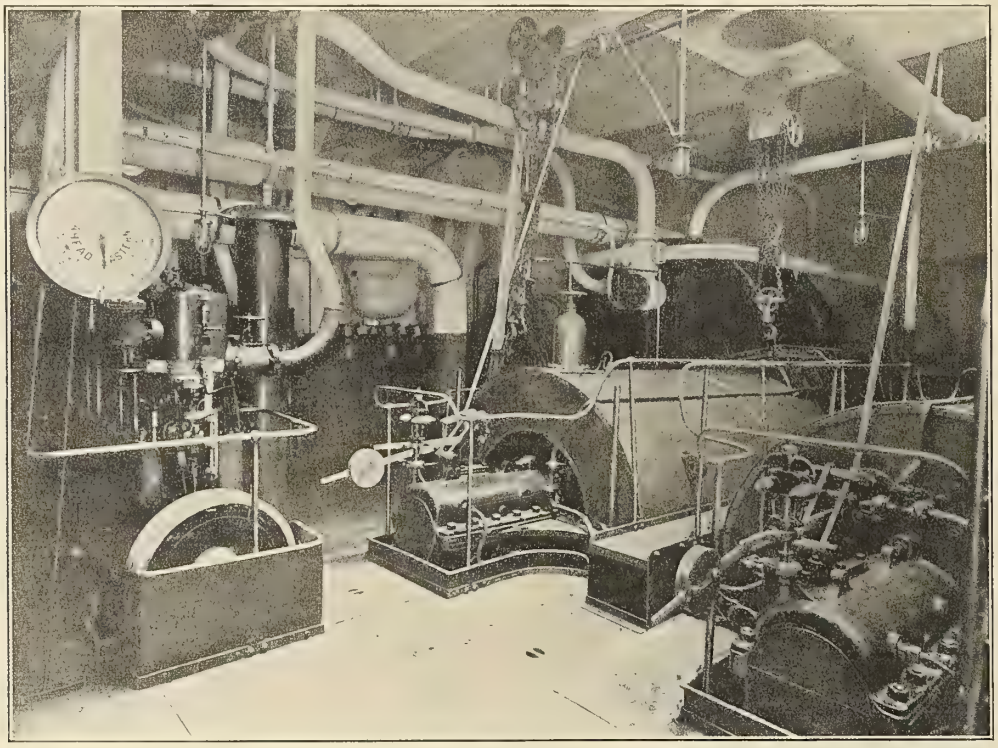
This country does not possess any definite rule on which a load line can be based, yet it owns about 4,000,000 tons of shipping (an increase of more than 200,000 tons over last year), and this would therefore seem to be more than a sufficient reason for enacting some suitable law to regulate the loading of such an important and (let us hope) ever increasing mercantile marine.

According to a weekly shipping paper recently published, it was stated that Germany appears to be in favor of adopting some regulations for the establishment of an international law of load line. No doubt other maritime countries would feel likewise inclined in the hope of doing away with the differences existing between the maritime nations of the commercial world; and although it can scarcely be expected that an understanding could be arrived at without much time and discussion, yet if such desirable object were ultimately attained the shipping interests of this country would be placed on an equal footing with those of other nations and we might be proud some day of having contributed in no small degree in the saving of many lives and much valuable property, both of which are essential to our own welfare in years to come. H. W.

TURBINE STEAMERS FOR THE IRISH CHANNEL.

Additional facts concerning the four new steamers built for the Midland Railway Company and mentioned in the September Marine Engineering are now obtainable. It will be remembered that the *Antrim* and *Donegal* are fitted with the usual twin-screw reciprocating engine. In this connection there was a mistake in the dimensions of the cylinders in the September issue. These engines are of the triple-expansion, four-cylinder type with cylinders 23, 36, 42, and 42 inches by 30 inches stroke.

The *Londonderry* and *Manxman* have compound Parsons turbines, consisting of one high-pressure on a central shaft and a low-pressure on each of the side shafts. The boiler equipment of all four vessels is the same and comprises the following: Two double-end and one single-end Scotch boilers, 22 feet and 11 feet 6 inches long respectively. The diameter of all is 15 feet 7 inches. There are six 47-inch furnaces in the double-end and three 47-inch furnaces in each of the single-end boilers. The grate bars are 6 feet 6 inches long, and the total heating surface is 12,461 square feet, and the area of the grate is 402 square feet. The boilers for the *Londonderry* are built for a working pressure of 150 pounds, while those for the other three ships are designed for 200 pounds boiler pressure. This difference in working pressure permits of a saving of 70 tons in the weight of the *Londonderry's* boilers. The total weight of machinery in the *Antrim* and *Donegal* is 730 tons, made out as follows: Boilers with water, 460 tons; engines, 210 tons; shafting, 60 tons. In the *Londonderry* the total machinery weight is 575 tons, which



VIEW IN THE ENGINE ROOM OF THE TRIPLE-SCREW TURBINE STEAMER MANXMAN.

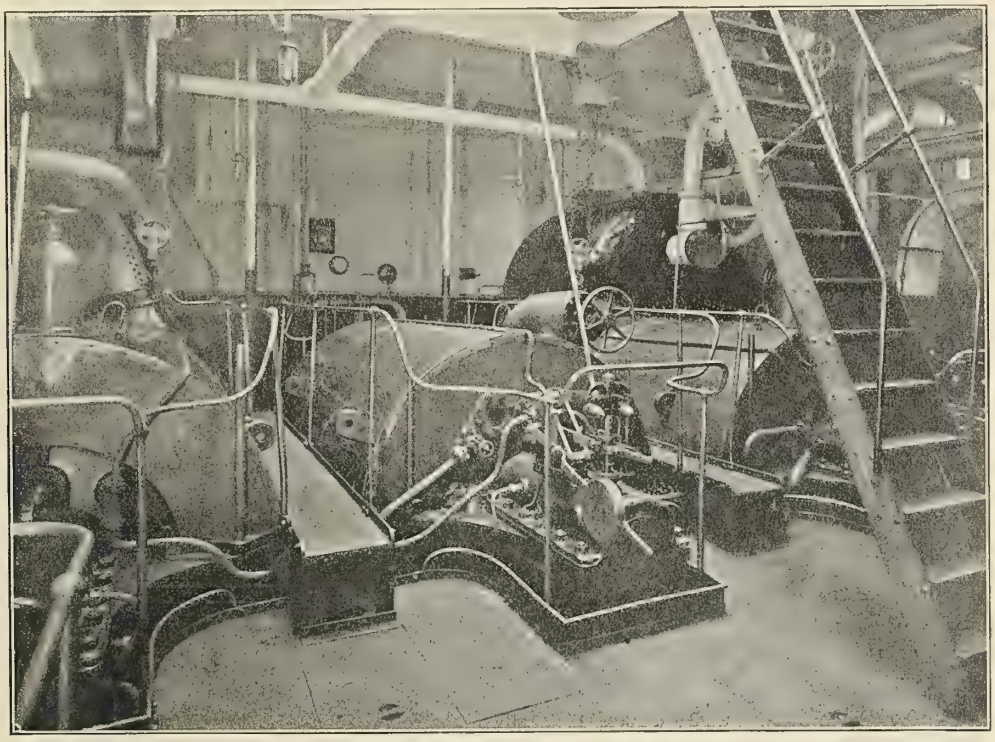
includes 390 tons for boilers and water, 160 tons for turbine engines, and 25 tons for shafting; for, on account of the higher speed of revolution, much lighter shafting can be used.

All four vessels were designed for a contract sustained speed on 6-hour trial of 20 knots. This was exceeded in each case, and the trials show decidedly in favor of the turbine vessels.

TRIAL SPEED.

	Antrim.	London-derry.
With two double-end boilers mean of six-hour trial, knots	20.6	21.6
Maximum speed for measured mile with two double-end boilers, knots	21.0	21.9
Maximum speed for measured mile with all boilers, knots	21.9	22 27

steel plate shell condensers are used on the reciprocating engines. There are two sets of Weir duplex air pumps 7 1-2 and 20 inches by 16 inches. The condensing machinery on the *Londonderry* consists of two steel plate condensers, into which the exhaust from the two low-pressure turbines is led, and three baffle plates are fitted to improve the circulation of the steam. To get the greatest amount of vacuum, so necessary for steam turbine machinery, there are two air pumps. One, termed the wet air pump, placed close to the condenser, is of the usual Weir duplex type; the other, the dry air pump, consists of a cylinder 20 inches in diameter placed on top of the circulating water engine cylinder, and has a stroke of 9 inches. This draws from an air chamber on the suction side of the wet air pump and both discharge to Weir float tanks, into which the condenser drains naturally.



ENGINE ROOM OF THE TURBINE STEAMER MANXMAN, SHOWING THE CENTRAL HIGH-PRESSURE AND THE TWO SIDE LOW-PRESSURE PARSONS TURBINES.

In comparing the speed of the two turbine vessels, the *Londonderry* and *Manxman,* it is interesting to note that the higher boiler pressure of the latter, and resulting increased boiler and engine weight, is more than offset by the increased speed of 3-4 of a knot, as shown in the following table:

MAXIMUM SPEED TRIALS.

	London-derry.	Manxman.
Steam pressure at boilers, lbs.	150	200
" " " H. P. receiver, lbs.	135	180
Vacuum, inches	28	29
Revolutions per minute, center shaft	670	530
" " " side shafts	750	610
Speed, knots	22.27	23

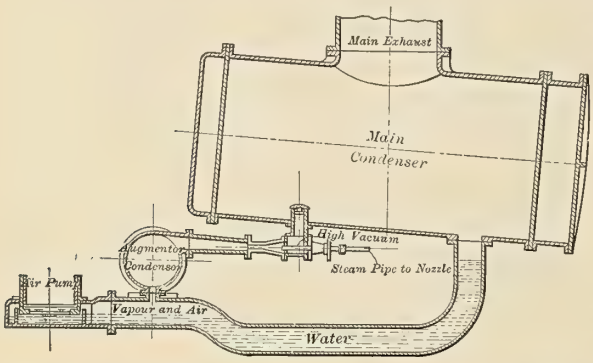
The usual forms of independent air pumps and separate

The vacuum on the *Manxman* was obtained by a somewhat similar arrangement of condensing apparatus, which is shown in the accompanying drawing. It consists of a "vacuum augmenter." The air pump is placed about 3 feet below the condenser, and the connecting pipe forms a water leg. From another point in the bottom of the condenser shell is taken a pipe in which is placed a steam nozzle to improve the vacuum in the condenser. This nozzle discharges to a second condenser, which in turn discharges into the main air pump suction. It is found that the amount of steam used by the nozzle was but 1 1-2 per cent. that used by the turbine at full load. The auxiliary condenser is supplied with circulating water in parallel with the main condenser.

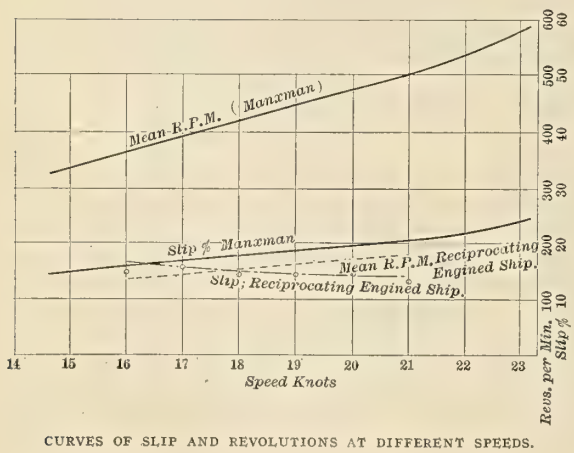
The slip of the reciprocating engine vessel was very satisfactory, amounting to only 13.6 to 15 per cent., the former at the highest speed, namely, 21 knots. The

curve is here reproduced, showing the slip at different speeds for the *Manxman.*

It is stated that the four vessels made very satisfactory trials, and that practically no vibration was noticed on the turbine vessels. For the above facts, as well as acompanying illustrations, we are indebted to London *Engineering.*



MAIN AND AUGMENTER CONDENSERS FOR OBTAINING HIGH VACUUM.


Mean R.P.M. (Manxman)
Slip % Manxman
Mean R.P.M. Reciprocating Engined Ship.
Slip, Reciprocating Engined Ship.
14 15 16 17 18 19 20 21 22 23
Speed Knots
Revs. per Min. 100 200 300 400 500 600
Slip % 10 20 30 40 50 60

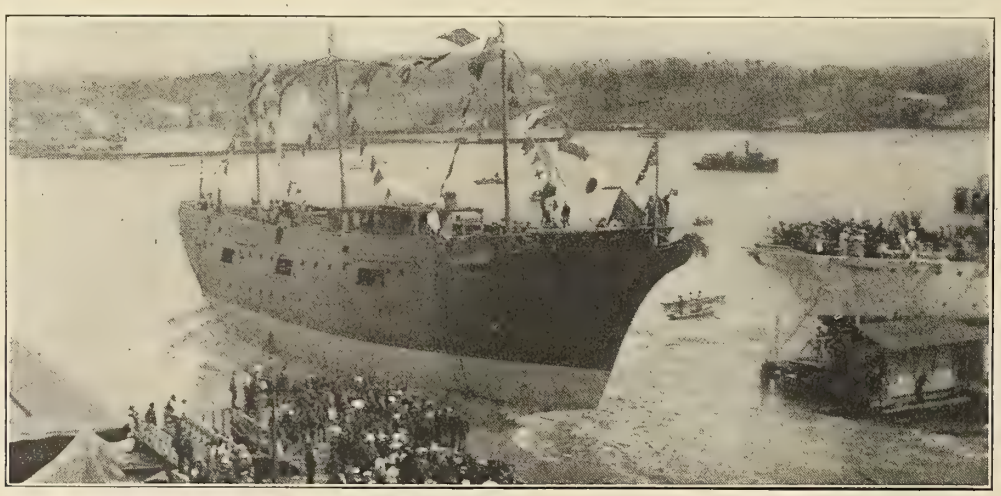
CURVES OF SLIP AND REVOLUTIONS AT DIFFERENT SPEEDS.

United States Training Ship Intrepid.

Mare Island Navy Yard was the scene of much interest on October 8, when the new United States steel training ship *Intrepid* was launched. The *Intrepid* has been designed as a sailing vessel in recognition of the doctrine, now generally conceded by naval officers, that the best school for twentieth century men-of-warsmen is a sailing ship. The *Intrepid* has a bark rig and is of the following dimensions:

Length on board load water line.....176 ft. 5 ins.
Beam, extreme ..... 45 ft. 7 3-4 ins.
Mean normal draft..... 16 ft. 5 1-4 ins.
Corresponding displacement ..... 1,800 tons

The hull is built of steel throughout. While the vessel is to be propelled by sail, there is an auxiliary engine in the boiler room in which is a Scotch boiler for supplying steam to auxiliaries, which include electric light plant, evaporators for supplying fresh water, drainage and fire pumps, and capstan and windlasses. The battery consists of six 4-inch rapid-fire guns; four 6-pounders; two 1-pounders, and two Colt and machine guns. In addition to a commanding officer, the *Intrepid* will carry 9 ward room officers, 6 warrant officers, and 320 men.



UNITED STATES TRAINING SHIP INTREPID, LAUNCHED FROM THE MARE ISLAND NAVY YARD.

Cost of Government-Built War Ships.

Rear-Admiral W. L. Capps, chief constructor of the navy, in his annual report, dealing with the work on the battleship *Connecticut,* building at the New York yard, says that despite every effort to reduce the cost of this the first battleship to be constructed in a navy yard to the most economical basis, it can hardly be hoped that the work will be done as cheaply as when performed in private shipbuilding yards, whose rates of pay for nine hours' work are, in many cases, less than those being paid for eight hours' work at the navy yard.

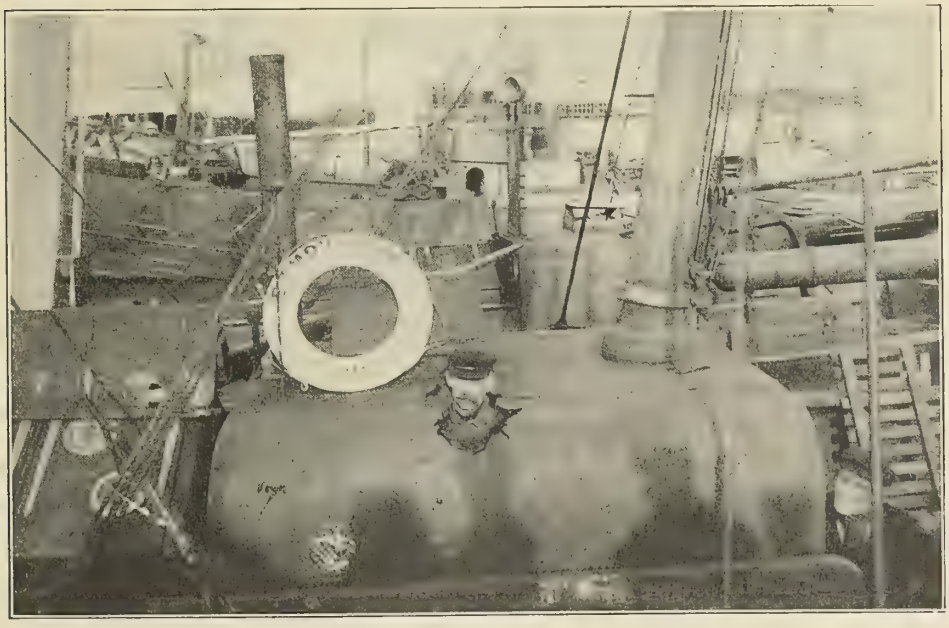
"It may also be noted," he says, "that private ship yards do not pay their per diem employees for holidays or when on leave, whereas a very large proportion of per diem employees on the *Connecticut* receive pay for fifteen days' leave and seven public holidays during the calendar year, without any work being done in return."

THE RUSSIAN NORTH SEA INCIDENT.

Interest in the events of the Russo-Japanese war in the far east is suspended on account of the meeting of the Russian squadron, leaving the Baltic sea for the seat of war, with the Hull fishing fleet in the North sea. The daily papers have given such full accounts of this outrage that it is only necessary to here mention briefly the reported facts of the incident, which resulted in the sinking of one trawler, the damage of two other boats, as shown in the accompanying illustrations, and the killing of two officers in the fishing fleet.

About 1 o'clock on the morning of October 21 the two Hull fishing fleets, called the Gamecock fleet and the Northern fleet, were fishing about 220 miles northeast of Spurmhead, the weather at the time being slightly hazy. The crews of the fleet noticed the outlines of what appeared to be war vessels and torpedo boats, and soon after were dazzled by search lights from these vessels. This was immediately followed by opening fire on the part of the war vessels upon the fishing fleet, and the bombardment lasted for twenty minutes. Fortunately the loss on the fishing fleet was

THE FISHING TRAWLERS MINO AND MOULMEIN.



THE TRAWLER MOULMEIN OF THE HULL FISHING FLEET, STRUCK BY SHELLS FROM THE RUSSIAN FLEET IN THE NORTH SEA.

[Photographs by James Fisher, Hull, Eng.]

very small, considering the number and size of the shots fired, but the trawler *Crane* was sunk, two of her crew killed, and several injured. The *Moulmein* was struck by round shot, as shown in the illustration, and the *Mino* fared even worse, as she had eight holes in her side plating, fortunately above the water line.

The firing ceased as suddenly as it had started, and the Russian fleet proceeded on its course. The excitement which followed the report of this incident in England is well known, as is also the delay in receiving any adequate explanation from the Russian admiral, who proceeded to Portugal before reporting. His report was as curious as the incident was tragic. He states that he had seen Japanese torpedo boats and had fired upon them. While awaiting the convening of the peace conference, called to establish the blame for this tragedy, the gist of the matter appears to be that the Russians, sailing from home with new and untried ships and crews, were so overwrought by fear or excitement of a midnight attack, that they mistook the peaceful fishing fleet for a flotilla of Japanese torpedo boats, and believed their only salvation was to sink them on the spot.

RESULT OF RUSSIAN SHELLS ON THE TRAWLER MOULMEIN. THIS BOAT WAS STRUCK IN MANY PLACES.

Engineering Positions.—The United States Civil Service Commission announces that in January examinations will be held for the following engineering positions: On January 4 and 5, to fill three vacancies of civil engineer student in Department of Agriculture at not exceeding $50 per month each; on January 18 and 19, an examination for the position of irrigating engineer in connection with the irrigating and dranage investigations in the office of the Experimental Stations, Department of Agriculture, at a salary of from $1,500 to $2,000 per year. Further particulars and application forms may be had by applying to the commission, Washington, D. C.

NAVAL ARCHITECTURE.—II.*

BY SIR WILLIAM H. WHITE, K.C.B., F.R.S.

BRITISH MERCHANT SHIPPING IN 1904.

The growth of the British mercantile marine, during the last ten years, has been both great and continuous, as will be seen from Table 1, furnished by the authorities of that great organization, Lloyd's Register of British and Foreign Shipbuilding.

In 1903 there were launched 697 vessels of nearly 1,200,000 gross tonnage, and 41 war ships of 152,000 tons displacement. At the close of 1902 the British register contained 5,037 steamers of nearly 4,500,000 tons, and 2,384 iron steamers of 1,120,000 tons. The total for the British empire was 8,553 steamers of 14,193,000 tons; all other maritime countries combined owning 9,228 steamers of less than 13 million tons. Including sailing ships the total for the British empire was 11,134 vessels aggregating over 15 million tons; all other maritime countries combined owned 18,809 ships, with an aggregate tonnage of 17,637,000 tons. It is universally agreed that in economy of first cost, and in speed of construction, British shipbuilding has a considerable advantage, due, no doubt, chiefly to the fact that Great Britain took the lead in the introduction of both iron and steam ships, and has had the advantage resulting from the training of two generations of skilled workers, and of the enterprise of ship owners and shipbuilders.

The growth in the size of individual ships during the last ten years has been most remarkable. It has been stated that in 1894 there was building only one ship of 10,000 tons, which was launched in the following year. Table 2 has been prepared by Lloyd's Register, and gives the names of vessels of over 10,000 tons (gross) launched during the years 1894 to 1903.

At the end of 1903 the largest vessel afloat was the

*Paper read before the International Engineering Congress, St. Louis, Mo., October 8, 1904.

TABLE 1.—VESSELS BUILDING IN THE UNITED KINGDOM ON THE 31ST MARCH IN EACH YEAR FROM 1894 TO 1904, INCLUSIVE.

(*War ships not included.*)

Year.	Steam.		Sail.		Total.	
	Number.	Tons (gross).	Number	Tons (gross).	Number.	Tons (gross).
1894...	346	663,396	68	61,812	414	725 208
1895....	310	628,605	46	27,713	356	656.318
1896....	341	736,472	59	32,792	400	769.264
1897....	388	810,439	40	18,042	428	828,481
1898....	579	1,181,036	27	4,085	606	1,185,121
1899....	568	1,382,289	29	3,426	597	1,385.715
1900	511	1,249,099	43	11,323	554	1,260,422
1901....	415	1,294,163	29	8 953	444	1,303.116
1902....	401	1,213,504	30	26,840	431	1,240.344
1903....	382	963.365	43	11,321	425	974.686
1904 ...	353	973 511	45	15.153	398	988,664

Baltic, of nearly 24,000 tons gross tonnage, which commenced her service in June, 1904. It is unnecessary here to explain the economic advantages attaching to increase in the size of ships, or its effect upon the cost of over sea transport. But it may be interesting to state that, whereas in 1890, the average gross tonnage of British steamers (exceeding 100 tons) was 1,570 tons, in 1902 it was 2,200 tons. This average includes a large number of yachts, river and coasting steamers, and other vessels of less than 200 tons gross. In Table 3, prepared by Lloyd's Register, the size of merchant and other vessels exclusive of war ships launched in the United Kingdom during 1903 is indicated.

TABLE 2.

Name.	Tonnage.	Year.	Name.	Tonnage.	Year.
Georgic.....	10,077	1895	*Celtic*.....	20.904	1901
Pennsylvania...	13.333	1896	*Minnetonka*.....	13,398	1901
Cymric.....	13,096	1897	*Walmer Castle*...	12'546	1901
Briton.....	10,248	1897	*Noordam*.....	12,531	1901
Medic.....	11,985	1898	*Rijordam*.....	12,527	1901
Afric.....	11,948	1898	*Athenic*.....	12,234	1901
Romanic.....	11,394	1898	*Haverford*.....	11,635	1901
Statendam.....	10,491	1898	*Merion*.....	11,621	1901
Oceanic.	17,274	1899	*Cedric*.....	21,035	1902
Ivernia.....	14,058	1899	*Arabic*.....	15,801	1902
Saxonia.....	14,281	1899	*Carpathia*	13.564	1902
Minneapolis....	13.401	1899	*Cretic*.....	13.518	1902
Saxon.....	12.385	1899	*Corinthic*.....	12,231	1902
Persic.....	11.973	1899	*Ionic*.....	12.232	1902
Winifredian....	10,405	1899	*Hellig Olav*.....	10,085	1902
Bavarian.....	10.387	1899	*Baltic*.....	24,000	1903
Minnehaha.....	13,403	1900	*Republic*.....	15.378	1903
Suevic.....	12,500	1900	*Kenilworth Castle*.....	12,975	1903
Runic.....	12 482	1900	*Armadale Castle*.	12,973	1903
Canopic...	12.097	1900	*Slavonia*.....	10.606	1903
Vaderland.....	12,018	1900	*Macedonia*.....	10.512	1903
Zeeland.....	11.905	1900	*Marmora*.....	10.509	1903
Tunisian.....	10.576	1900	*United States*.....	10,095	1903
Devonian.....	10.418	1900			

The mercantile fleets of the world, at the end of 1902, included 84 steel steamers of 10,000 tons and upward. Of these, 39 were owned by the United Kingdom, 26 belonged to Germany, 9 to the United States, and the remainder to France, Holland, and Denmark. At the same date there were 145 vessels of 7,000 to 10,000 tons, 109 belonging to the United Kingdom, 22 to Germany, and 7 to the United States.

The great cargo steamers, with enormous carrying capacity, can be profitably worked at low rates of freight, and enable transport over sea to be conducted with remarkable economy. In the writer's presidential address

TABLE 3.

Tonnage.	Steam.	Sail.	Tonnage.	Steam.	Sail.
Under 50 tons.....	5	5	6,000 to 6.999 tons..	9	..
50 to 99 tons.....	48	2	7 000 to 7,999 tons..	12	..
100 to 199 tons.....	116	31	8,000 to 8.999 tons..	1	..
200 to 499 tons.....	113	17	9,000 to 9,999 tons.	3	..
500 to 999 tons.....	45	5	10,000 to 11,999 tons.	3	..
1 000 to 1,999 tons..	92	5	12,000 to 14,999 tons.	2	..
2,000 to 2,999 tons..	52	1	15,000 tons and above.....	4	..
3.000 to 3,999 tons..	77	..			
4 000 to 4,999 tons..	45	..	Total...	632	65
5,000 to 5,999 tons..	5	..			

at the Institution of Civil Engineers he gave many illustrations of these facts, showing that the cost of fuel per thousand ton-miles has been reduced to 2 1-2 to 3 pence, and that in the White Star steamer *Suevic* an expenditure of about 3 shillings on coal drives a ton weight from England to Australia. The *Ivernia* and *Saxonia* of the Cunard line exceed 20,000 tons in displacement, and steam 15 1-2 knots on 140 tons of coal a day. The cargo steamer *Monarch,* carrying 11,600 tons, dead weight, averaged over 11 knots on two Atlantic voyages, burning about 48 tons per day. The outward voyage was in ballast; on the homeward she was fully laden. Quick despatch in loading and discharging these enormous cargoes is essential, as the stay in port must be minimized if the best economic results are to be obtained. By the aid of mechanical lifting appliances a mixed cargo of 11,000 tons dead weight can be discharged in 66 hours. In no department of ship equipment has greater advance been made than in the device and construction of these lifting appliances. Careful organization is required also for the collection and warehousing of the cargo, in order to shorten the period of stay in port. As an example of what can be done, it may be stated that an excellent authority recently gave 25 to 30 shillings per ton as the cost of conveying ordinary cargo from the United Kingdom to Bombay, which is about 1-35th of the average cost of transport of goods by railway in the United Kingdom.

On June 30, 1904, there were 361 merchant ships under construction in the United Kingdom. Of these, 132 were less than 1,000 tons, 70 from 1,000 to 3,000 tons, 137 from 3,000 to 6,000 tons, 11 from 6,000 to 9,000 tons, 4 from 9,000 to 12,000 tons, and 7 more than 15,000. It will be seen, therefore, that while the average dimensions of ships are increasing and a larger number of ships are built of extreme dimensions and tonnage, use can still be found for great numbers of cargo steamers of moderate size. The supreme position of the British mercantile marine is due chiefly to its development of cargo steamers, and (to quote the writer's own words) "the largest share of the work of the world in over-sea transport is still done by the much despised 'tramp' steamer." By close study of requirements, and successive improvements made by shipbuilders, engineers, and ship owners, wonderfully economical results have been achieved. For example, a vessel about 360 feet long, 47 feet broad, 30 feet deep, and drawing 24 to 25 feet when loaded, can carry 6,500 tons dead weight, and steam at 11 knots with a consumption of 27 tons of coal *per diem.* The cost of fuel per thousand ton-miles is less than 3 pence, and under the present conditions of the shipbuilding trade the first cost would be about £40,000. When

such economy is realized in steamships, which secure greater speed and regularity of service, it is no wonder that they are gaining upon sailing ships even for the longest ocean voyages.

Sailing ships have been continuously diminishing in importance during the last ten years. In 1903 only 65 sailing vessels of 25,000 tons gross were launched in the United Kingdom. Under modern conditions steamships are reckoned, for commercial purposes, as equal to four or five times their tonnage in sailing ships; and as the mercantile marine of the United Kingdom contains so small a proportion of sailing vessels, in comparisons of efficiency or carrying capacity, these circumstances must not be overlooked. There is a keen desire on the part of British ship owners to keep abreast of the necessities of traffic, and to secure the greatest possible economy, which leads them to substitute new for old ships long before the latter are worn out. In 1902, for example, about 320,000 tons of British ships were sold to foreign owners as against purchases of 65,000 tons. The sailing tonnage of the United Kingdom decreased by about 92,000 tons in 1903, while the steam tonnage increased by 497,000 tons, and the net increase of British tonnage, during 1903, amounted to 405,000 tons. The net increase of the world's tonnage in 1903 was 1,402,000 tons, steam tonnage being increased by 1,545,000 tons, while sailing tonnage was diminished by 143,000 tons.

The *Baltic* is the first modern steamship exceeding the *Great Eastern* in length between perpendiculars, displacement, and tonnage, but she is inferior to that ship in breadth and molded depth. She is 710 feet between perpendiculars, and about 726 feet in length over all, 75 feet beam, 49 feet molded depth, with engines developing 13,000 to 14,000 I. H. P. and a speed of 16 to 17 knots on service. At 32-foot draft she displaces 34,000 tons, and if depth of water were available, she could be safely loaded to 37 or 38 feet, the displacement being then over 40,000 tons. She can carry 3,000 passengers in addition to her crew of 350 officers and men, and her cargo capacity is enormous. To deal rapidly with this cargo she is fitted with very powerful and numerous lifting appliances. In this latest example of the intermediate class of passenger and cargo steamer with moderate speed is to be found an epitome of the progress made in shipbuilding and engineering during the half century which has elapsed since Brunel commenced his studies for the *Great Eastern*, and the genius of the great engineer stands out the more clearly as the comparison between the two vessels is completed. Considering the date and circumstances of her construction, the *Great Eastern* is still the most remarkable vessel ever completed, although she is no longer the largest.

Hitherto the intermediate class of passenger and cargo steamer has not exceeded 15 to 16 1-2 knots in speed, but in the *Coronia* of the Cunard line, launched in July, 1904, a new departure has been made, and a service speed of 18 knots has been decided upon. Her dimensions are not so great as those of the *Baltic*. She is about 48 feet shorter and 3 feet narrower, her gross tonnage is 3,000 tons less, and her displacement at 32 feet about 30,000 tons, 4,000 tons less than that of the *Baltic*. Her total accommodation is for 2,650 passengers and 450 crew. The engines are to develop over 20,000 I. H. P., or fully 50 per cent. more than the power in the Baltic. The dead weight capacity is 12,000 tons, considerably less than that of the *Baltic*. A sister ship of the same size, but with turbine engines, is also in hand. They are interesting vessels, standing midway between the previous intermediate steamers and the *Oceanic* of the White Star line, which is about 27 feet longer, 5 feet narrower, and about 2,000 tons less displacement, but has engines of one-third greater power, and a sea speed of nearly 21 knots. The *Oceanic* has quite exceptional cargo capacity for an Atlantic liner, but is necessarily inferior in that respect to intermediate steamer (like the *Cedric*) of about the same dimensions with half the engine power, and 4 to 5 knots slower.

The *Kaiser Wilhelm II.* slightly exceeds the *Oceanic* in dimensions, but is of much greater gross tonnage (20,000 against 17,270 tons). Her load draft is less, but at the same draft the two vessels would have approximately equal displacements, say about 26,000 tons at 29 1-2 feet. The German ship has engines of 50 per cent. greater power and is from 2 1-2 to 3 knots faster. Her dead weight capacity is, therefore, much less, while her coal consumption is much greater, and she can carry very little cargo as compared with the *Oceanic*.

These are interesting illustrations of the widely different distributions required with practically the same displacement in order to fulfil varying conditions of speed and carrying power or accommodation. To the naval architect the close study and careful analysis of examples in past practice is full of interest, and conducive to progress in later designs.

The designs of the new Cunard steamers, which are to be capable of maintaining a speed exceeding that of the fastest German ships by at least a knot, furnish the latest illustration of the great increase in size and cost which accompanies increase in speed. They will be 760 feet long between perpendiculars, 88 feet broad, and over 60 feet molded depth. Accommodations will be provided for nearly 3,000 persons. To secure the intended speed the engine power will have to be about 70 per cent. greater than that of the *Kaiser Wilhelm II.*, and the corresponding increase in coal consumption will make such large demands on the dead weight capacity that only a very moderate amount of cargo will be carried. In the agreement with the British government it is contemplated that each of the two ships will cost £1,300,000. The use of steam turbines instead of reciprocating engines, and of four shafts and propellers, involves an experiment of great novelty; but it has been undertaken after full enquiry, and promises to be successful, while its potential advantages are very considerable.

SPECIAL CLASSES OF CARGO STEAMERS.

The last ten years have been marked by considerable specialization in designs for steamers, in order to adapt them for the conveyance of various descriptions of cargo, or to secure other advantages. Side by side with this specialization has proceeded the development of the tramp steamer, which seeks for cargoes in all quarters, and generally manages to accommodate any cargo that offers.

Oil-Tank Steamers.—Among these special types oil-tank steamers stand prominent. Eighteen years ago only ten steamers carried oil in bulk on over-sea voyages, and these vessels were of moderate size, not exceeding 240

feet in length and 1,500 tons (gross). In 1902 there were nearly 200 tank steamers, many of large size. The largest is 512 feet long, of 21,000 tons load displacement, fitted to carry 11,000 tons of oil in 16 tanks, and capable of carrying 12,500 tons dead weight. The maximum speed is 14 knots. In the design of these vessels difficult problems have to be solved in regard to subdivision, stability and strength of structure, in consequence of their liquid cargoes. In working them, remarkable results have been achieved, in the direction of adaptability for general cargoes when oil is not carried.

Meat Carriers.—These steamers form another group which has been greatly increased in size and number. About 160 vessels of this class are now employed in the carriage of frozen meat. They are fitted with powerful refrigerators, and built with elaborate arrangements for the insulation and ventilation of storage chambers. The largest vessels approach 500 feet in length, with dead-weight capacity of 10,000 tons, and each can carry 100,000 carcases. It is estimated that in the aggregate this section of the mercantile marine can carry from 9 million to 10 million carcases.

Ore Carriers.—Vessels of this type, of great size, have also been built with special means for shipping and discharging cargoes. The *Grangesburg* is the most notable of these, having been completed in 1903. She is of the turret type, 440 feet long, 10 1-2 knots speed, with about 10,000 tons dead-weight capacity. She has 24 derricks carried on 7 pairs of masts, and 12 large hatchways. The whole cargo can be discharged in 35 hours. And it is stated that she will carry and discharge over 200,000 tons of ore per annum in her service between Sweden and Rotterdam.

Cable-Laying Steamers.—These steamers date from 1874, when the *Faraday* was specially built for this service. Her length is 360 feet, breadth 52 feet, and gross tonnage 4,900 tons. She can carry 4,300 tons cable, and nearly 1,600 tons of coal and stores on 26 feet draft, the speed being 8 to 9 knots. The largest cable-laying ship on service at present is the *Colonia* (built in 1902), her length being 487 feet, breadth 56 feet, 8,000 tons gross, with speed of 12 to 13 knots. On her first voyage, while laying the Pacific cable, she carried over 3,500 miles of cable, weighing nearly 7,700 tons, besides coal and stores, on 26 feet draft. On the voyage she steamed over 3,400 miles and consumed nearly 9,000 tons of coal in 5 months and 10 days. The cable was paid out at the rate of 210 miles per day, the maximum depth of water on the route being 3,400 fathoms.

Turret-Type Steamers.—Of the many special forms of cargo steamers proposed or built in recent years the turret type originated by Messrs. Doxford has found most favor; that firm has constructed a hundred ships, and similar vessels have been built by other ship yards. The latest for general trade is 390 feet long, 5,500 tons gross, and carries nearly 9,000 tons (dead weight) on 24 feet draft at 10 knots, with less than 2,000 horse power. The American whaleback is the progenitor of the turret type.

Single-Decked Steamers.—Vessels of this type of large size have also been recently constructed, special arrangements being made to ensure rigidity in the structures. Vessels of this class carrying 6,000 tons dead weight are on service, and others capable of carrying 12,000 tons have been designed but not yet built.

MATERIALS AND METHODS OF CONSTRUCTION IN 1904.

Up to the present time mild steel holds its own, and there is no marked or general desire to use stronger steel, or to introduce other materials. Experiments made under the writer's direction more than 25 years ago showed that it was possible to obtain steel plates, bars, and rivets having an ultimate tensile strength of 38 to 40 tons per square inch, with good ductility and satisfactory working qualities, if it were found desirable to use such material; but hitherto considerations of durability and stiffness have determined the lower limit of scantlings in most ships, and mild steel has met all requirements. As dimensions and engine powers of war ships have been increased, however, recourse has been had to stronger steel, beginning with torpedo boat destroyers. Similar material has also been specified by the writer for important portions of the structures of large war ships since 1898. In small cruisers it has been extensively used. With this stronger material it is found desirable to drill the holes, but no other special treatment is necessary. The gain in strength, measured by the comparative elastic limits, is from 20 to 25 per cent. over that of mild steel in the material which has so far been used by the British admiralty. It is most important, in specifying for the stronger steel, to define the elastic limit, and to ensure its existence by suitable tests, if full advantage is to be secured.

Admiralty practice has always left manufacturers free in regard to the chemical composition of the material; but the use of open-hearth steel (either acid or basic) is insisted upon for all important parts of the structures of ships. Recent experiments have shown that, so far as plates and bars are concerned, it would be possible, with certain qualities of nickel steel, to obtain still greater strength with good working qualities. It does not appear, however, that proof has been given hitherto that rivet steel of the same quality could be readily worked, or that entirely satisfactory joints could be made in the combinations of plating forming the shells and decks of ships. This is a most important point, and is sometimes overlooked in recommendations of the use of material of high tensile strength. When stronger steel is used, modified structural arrangements are undoubtedly of great importance; because, as the thicknesses of plates and bars are reduced, there is a greater liability to buckling under compressive strains. As regards corrosion, the use of high percentages of nickel would probably furnish the necessary durability, even for very thin plates; but, with reduced scantlings, the provision for ready means of access for examination, cleaning, and painting, are obviously of great importance. The danger of failure by buckling has been shown to be considerable (unless met by proper structural arrangements and stiffening) in many light draft vessels when making over-sea passages to their regular stations. In later years, further illustrations of the necessity for precaution have been afforded in torpedo boat destroyers. It need hardly be said that recognized principles of construction make it obvious that, in order to secure the best association of lightness

and strength, stiffness should be obtained wherever possible by suitable structural supports to thin plates rather than by increased thicknesses in the plates themselves. In many instances, however, this fundamental principle of construction is overlooked, and unnecessarily heavy scantlings are insisted upon, or unwise additions to structure made.

(To be continued.)

Moving Troops in the Philippines.

Uncle Sam's plan of moving a regiment of soldiers from one island to another in the Philippine archipelago is quite perfect. The regiment destined to embark for new territory is first assembled on the beach near the point of embarcation, where arms are stacked and the baggage of each company is made ready to put on board the lighters. After this is safely shipped, the soldiers board the same boats. The work is done under the general supervision of the quartermaster. All the baggage is turned over to him for transportation and proper receipts taken. Natives are in the employ of the quartermaster's department to handle the baggage while the soldiers guard the property. The twelve companies, band, and non-commissioned staff of a regiment can, under the present arrangement, be gotten aboard a transport from the shore in a day very easily. Formerly there was much delay and annoyance due to lack of lighters, tugs to haul them and proper transportation facilities.

There is always fun when the soldiers take to the lighters or small boats on the sandy beaches. The surf usually runs high and all at least get their feet wet. Sometimes the row boats are used to bridge over the space from dry land to the lighters; sometimes the boats are used as ferries. There have been very few drowning accidents. The soldier is required to remove his equipment, so that in the event of the boat sinking he would not be taken down by its weight. Many of the lighters are only native craft, but they hold many soldiers, one or more companies finding room with some of their baggage on a single boat. Once on the lighter the rest is easy as the tug boat tows the lighter to the sides of the big transports.

Each soldier is assigned a bunk on board, and the transport weighs anchor and steams away, but before we can land again we have to touch at Marivalles, the quarantine station near Manila, and be fumigated.

THE UNITED STATES BATTLESHIP OHIO ON TRIAL, SHOWING ENORMOUS BOW WAVE.

[Photograph copyright, 1904, by G. o. P. Pitkin.]

Clothes are removed and tagged and subjected to the steam fumigation treatment for destroying germs. We bathe, receive back our clothes and return aboard, the operation of fumigating a regiment taking but one day.

When the transport drops anchor off our port, once more we take to the native craft of quartermaster's lighters for landing at the new station. Often two or three of the boats are strung along, one behind the other, and towed. It is quite a sight to look down upon one of these soldier-packed lighters; every soldier is in khaki and the scene is most stirring and war-like. The lighters are hauled up alongside the wharves or once more at the beaches, and the soldiers land as they embarked. Often there may be two or three of the lighters moored along side each other at the place of landing, and then the soldiers in the outer boats must scramble over the inner boats to the wharf. Yet there is little or no confusion; everything is done according to a well-wrought plan;

EMBARKING AND DISEMBARKING OUR TROOPS IN THE PHILIPPINES.

Waiting on the hot sands for the boats. Embarking in a high surf. Afloat.
Landing at Marivalles for Quarantine. Barges waiting alongside for the soldiers. Towing ashore.
The side tow. Disembarking across several lighters. The barges in tow.

seldom is anything lost and no one is hurt. I have seen several regiments moved this way, from island to island, without the loss of a man, or a piece of baggage, or equipment of any sort.

An Ex-Soldier.

Marine Engineering

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE twelfth annual meeting of the Society of Naval Architects and Marine Engineers, which took place in November, at a time following a long depression in shipbuilding, showed, fortunately, no lack of interest on the part of the members. The meeting was well attended and as a social gathering, is becoming more and more an event of importance, as affording a common meeting place for shipbuilders from the east and the west. The society has a strong personal hold on its members. With a membership of about nine hundred, its finances in good condition, there being no liabilities, the outlook under wise management for the society's future usefulness in the profession is decidedly favorable. Regarding the technical sessions, with which, strictly speaking, we have alone to comment upon, this year's meeting may be considered a notable success, as the secretary, through the co-operation of the members, was enabled to publish a set of papers which, taken as a whole, are of very high character. As usual, and natural this year in view of the relative amount of naval and merchant tonnage now under construction, half of the papers presented were on topics pertinent to war ships. One, on the sea-going battleship, gives a most careful and complete analysis of the conditions which effect the design. The importance of each function of the ship is weighed according to its relation to the completed vessel, and deductions are made for a new type of battleship which, however, proves to be much like the latest design in the American and British navies. Data of trial trips and dimensions of government vessels are presented in several papers, and an unusual and concise arrangement of launching data, representing the practice on the two seaboards, are recorded. The other papers deal with a variety of topics of interest to the profession, and an especially valuable treatise on the maintenance of marine machinery deals with a subject, which is, unfortunately, often too little considered by the designer. It is a most careful review of the operating conditions and troubles present in the engine room. The designer should have full knowledge of running conditions at sea, with attending breakdowns, in order to design machinery to give any degree of satisfaction. Also, however carefully the layout of the engine and boiler rooms may have been considered, unless the machinery is properly cared for, serious trouble is bound to result.

That pleasure craft are growing yearly more numerous and popular, and the interest in them becoming more general, is shown by the spirited discussion which arose over several papers presented. The remarkable strides which the autoboat has made during the last year in point of speed seemed impossible two years ago. Just what ultimate position this type of pleasure boat will take is, of course, unsettled, for many consider it but a passing fad; but true it is, that the speed which has been maintained by some of the new boats marks an epoch in speed possibilities.

Unfortunately the transactions of the society have not as yet contained any information relating to the marine steam turbine, which may be attributed to the fact that the first turbine-propelled vessel is yet to be laid down in this country. One of the difficulties met with in turbine machinery is the high rotative speed of shaft and propeller, causing supposedly undesirable cavitation. The design of suitable propellers for such high revolutions has also been a much mooted question, with but little experimental data for guidance. The profession is to be congratulated on having so much information on this latter subject in a paper presented by Naval Constructor

Taylor at this annual meeting. His experiments, with propellers of a variety of pitch as well as different blade areas, cover a range which has hitherto been unexplored. The method of presenting the exhaustive data is so simple that it is within the grasp of any intelligent designer. Abstruse subjects received scant attention at this meeting, and practically all the papers were prepared by men of experience.

THE annual report of Rear Admiral Charles W. Rae, engineer-in-chief of the navy, recently issued, shows a most active condition in the Bureau of Steam Engineering. With repair work conducted at the navy yards on the Atlantic and Pacific annually increasing in volume and character as additions are made to the fleet, the steam engineering plants have necessarily demanded larger buildings equipped with modern tools. The naval station at Cavite has been a busy one during the past year, as nearly three score government vessels and fifteen merchant ships were repaired to a greater or less extent. The year's expenditure at this station amounted to over three hundred thousand dollars—an indication of its importance. During the year, of the larger work in hand, two battleships and four protected cruisers have been placed in commission, and there are now thirteen battleships, eight armored cruisers, and five protected cruisers advanced to different degrees of completion. The report contains the official account of the removal of the two cruisers and two torpedo boats from the shipyards which were closed because of bankruptcy, to the navy yard, and forms interesting reading of these unfortunate events.

The amount of material inspected during the year was nearly half as much again as for the previous year, and reaches the enormous figure of nearly forty thousand tons. The Bureau has prepared plans for one battleship, two armored cruisers, two colliers and last, but most interesting of all, the three scout cruisers. It is the intention to fit one of these with reciprocating engines and the other two with steam turbines. In this latter connection the department has made extensive investigations concerning this new form of propulsion, and at the Annapolis experimental station a suitable laboratory is being equipped for testing steam turbines of the same make as those which are to be used for the scout cruisers. This experimental station is well under way, and the Admiral mentions many lines of research and testing which it is the intention to carry on. Boiler tests, under various air pressures, of two standard types of water-tube boilers used on the battleships, are incorporated in the report; both of these show a very high economic rating. Mention is made of the report of the board of liquid fuel, which has been published separately and contains a very great compilation of trials of liquid fuel apparatus conducted under the direction of the Bureau.

While the report shows a most satisfactory progress of new work in hand, the Admiral sounds a note of warning about the maintenance of the fleet. A modern navy without an efficient engineering personnel is deficient in one of its prime requisites and will fail in the hour of battle. The present condition of engineering in the navy is a cause of great anxiety on account of the few thoroughly trained commissioned engineers. As a result of the personnel bill of 1899, whereby the line and engineering staffs were amalgamated, the engineering force has been so seriously depleted that at present there are not enough officers to assign to the ships and to shore duty. As the requisite training and experience of an engineering officer cannot be obtained except by long service at sea, any steps to remedy this condition will necessarily require several years to bring the service to a point that is desired. The Admiral recommends that a selection be made each year from the midshipmen or ensigns, of a certain number of officers for engineering duty. Owing to the hard physical work and high temperatures which an engineer must necessarily be subjected to, he recommends that no engineer be required to serve at sea after he has reached the age of forty. In compensation for the years spent in one department, whereby the engineer cannot obtain the experience necessary for the command of a ship, he shall thereafter be assigned only to shore duty. Another recommendation is that all officers of the line be given sufficient engineering duty to render them qualified to take charge of this department. This plan is already under trial to a certain extent in the navy. So serious is the result of the lack of officers in the department that the Admiral recommends a reduction of the number of ships in commission. Regarding the warrant machinists who have performed such excellent service, it is recommended that the number be increased, permitting thereby more shore duty; that they receive the same rank as other warrant officers, and that they be graded for promotion.

The Efficiency of the Marine Oil Engine.

Editor Marine Engineering:

Articles have been written the last few months in which the gas plant, composed of gas engine and a gas producer, has been favored over all other kinds of power for marine use. Inasmuch as the producer-gas plant is no further advanced toward perfection than the oil engine, it would seem questionable to predict, too certainly the defeat of the crude oil Otto-cycle engine by the producer-gas plant. The writer has made a study of the oil engine for several years, and feels that a few remarks about the apparent merits of different kinds of power, as compared with the oil engine, in the shape that the oil engine is now, may not be out of place.

The producer-gas plant on shipboard must use a grade of gas having a heat value of about 150 B. T. U. per cubic foot of gas at 60 degrees F. and atmospheric pressure. This is above the average for producer gas. Illuminating gas has an equivalent of 600 B. T. U. in place of the 150 B. T. U. before stated. However, the richer gas is enough more expensive so that it cannot compete with the leaner gas. Owing to the use of the producer-gas the M. E. P. of the marine gas engine cannot be more than 70 pounds. The efficiency of the producer-gas engine is not reduced on account of the comparatively low M. E. P., since the leaner gas allows a pressure of compression of about 170 pounds against a maximum pressure of compression of 90 pounds with gasoline or illuminating gas. The lower M. E. P. will be a disadvantage only in causing the engine to be more bulky as well as heavier per H. P. Recently some reliable figures on the efficiency of different size producer-gas engines have appeared; they are given below. The figures are not all for the same make of engine, but as those turned out by the leading manufacturers differ only in small features and not in general principle, and also since these engines have all the same high-grade workmanship, a comparison of four engines, although of different makes, may be considered a comparison of four engines of the same make.

Make.	Brake H. P.	Thermal Efficiency, per cent.
Westinghouse	50	24.6
Crossley	140	26.85
Crossley	400	29
Premier	500	30.38

These figures are based on the brake horse power and the total energy of the fuel used in the cylinder. For engines of above 500 H. P. per cylinder, it appears that the efficiency would be above 30 per cent. The efficiency of the producer on land does not run above 85 per cent. and it is very probable that this figure will not be exceeded on shipboard. This will make the net efficiency of the producer-gas plant about 25 per cent. The temperature of the air and gas in the producer as it is drawn over the incandescent coals must be more than twice the absolute temperature of the atmosphere. This means that for each brake horse power of the producer-gas engine two cubic feet of gas per minute must be drawn through the hot coals in the process of the formation of the gas. It appears to the writer that it will be necessary to have a bulky apparatus to accommodate such a flow of gas. If it is possible to draw the air through the producer at a high velocity, or perhaps at a pressure above the atmospheric pressure, the bulk and the weight of the producer can be reduced. It would seem, however, that the producer would weigh about as much as the same power steam boiler in spite of any improvements which may be made to the producer.

In order that the producer-gas plant may have a fair show against the oil engine, the weight of the producer and its auxiliaries will be taken here to weigh but 75 pounds for an equivalent of the steam I. H. P. This figure is probably about one-half the actual weight.

In considering the crude oil engine there are several very great advantages which it has over the gas engine. The fuel fed to the former engine is rich, and for that reason the M. E. P. will be higher than the M. E. P. of the producer-gas engine. This increase in the M. E. P. should have an effect to decrease the weight per horse power. Since the fuel is not fed into the cylinder of the engine till it is needed, any pressure of compression can be used in the oil engine from the 500 pounds, which the Diesel uses, to a pressure of 90 pounds or lower if desired. Theoretically the efficiency of the internal combustion engine should increase with the pressure of compression or inversely with the clearance; however, owing to the upper limit to the ignition pressure which is obtained in the internal combustion engine, the efficiency would not increase even theoretically beyond a certain point. The actual efficiency of the engine depends upon the indicated efficiency and the mechanical efficiency. It is probable that the mechanical efficiency begins to fall off after the pressure of compression passes 100 pounds. The maximum efficiency of the internal combustion engine should be at about the point corresponding to a compression pressure of 200 pounds. This has not yet been proved to be the point but will be settled soon, and when settled can be used as the compression pressure for the oil engine, while the gas engine cannot exceed a compression pressure of 90 pounds with rich gas, or 170 pounds with the leaner gas. Owing to the fact that the oil engine can choose its own conditions it is probable that 35 per cent. efficiency is not at all unlikely. For marine work it seems best to have an engine of the four-cycle and single-acting type, although if this is an error on the part of the writer it does not affect the oil engine, as it can take any form which is possible to any internal combustion engine.

For an intelligent comparison between the merits of different plants using coal and oil, each fuel should be taken at prices so that the cost per unit of heat available will remain the same. The reason for this is that vessels are now being fitted to burn oil in place of coal. It is probable that the fuel oil is not much more expensive than coal on a basis of the heat units per pound of fuel.

The steamship *Mariposa,* running between San Francisco and Tahiti, was converted into an oil burner over two years ago, and for the comparisons made here the data were obtained for the most part from the report of the Bureau of Steam Engineering, 1902. The price of fuel was not stated, but coal at $3.00 a long ton seems to be about fair. The calorific value of the coal will be assumed about 14,000 B. T. U.; that of the crude oil about 19,000 B. T. U. Coal would cost 13.4 cents a hundredweight, and oil at the same cost per B. T. U. would cost 13.4 cents for 73 pounds. On this basis steam power would cost the same, as far as the fuel was con-

cerned, regardless of whether oil or coal was used. Oil at 13.4 cents for 73 pounds is about equivalent to 1.41 cents per gallon.

The *Mariposa* is 314 feet long, 41 feet beam, and 22 feet mean draft. The vessel was, at the time of being remodeled, fitted with tanks to carry 905.43 long tons of oil, sufficient to last the round trip from San Francisco to Tahiti and return, a distance of 7,098 nautical miles. The I. H. P. of the vessel is 2,500, and therefore the B. H. P. must be about 2,100. The power of the auxiliaries was not given. The second trip of the *Mariposa* was more economical than the first, owing to the experience gained on the first trip, and perhaps also on account of the fact that it was made at a slightly slower speed. On this second trip 734.14 tons of oil were consumed. On a basis equal to $3.00 a ton for coal, this oil would be worth $4.09 a ton, or the total fuel consumed on the trip would be worth about $3,000. The average efficiency on the trip may be assumed to have been about 9 per cent., based on the B. H. P. of the main engines. As the power of the auxiliaries is not known, it will be necessary to credit the main engines with the assumed power consumed by them; 995 tons of coal, at the above mentioned calorific value, would have been required to get the same results as were obtained with the 734 tons of oil. Using a gas producer and gas engine for the power we shall have to reduce the efficiency of 25 per cent. to 20 per cent. to allow for the extra power in the auxiliaries. The producer would use 448 tons of coal at $3.00 a ton, or a total of $1,344 for fuel for the producer-gas plant. Using oil engines for power, the efficiency of 30 per cent. would have to be reduced to 24 per cent. to allow for the auxiliaries. The equivalent of 2,500 steam I. H. P. would require 267 tons of oil at a value of $4.09 a ton, or a total value, for the oil engine plant for the trip, of $1,093.

In the following table the weights are obtained for total machinery, by assuming that for both steam plants 300 pounds per I. H. P., for the producer-gas plant 280 pounds, and for the oil engine 205 pounds.

Supposing that the *Mariposa* be equipped with any one of the four different types of power mentioned before, with fuel to make the trip to Tahiti and back the different weights will be as below:

	Machinery.	Fuel.	Total.	Cost of Fuel.	Saving.
Coal burning steam..	335 tons.	995 tons.	1330 tons.	$3 000	....
Oil burning steam....	335 "	734 "	1069 "	3,000	...
Producer-gas (coal)..	313 "	448 "	761 "	1.344	$1,656
Oil engine plant.....	229 "	267 "	496 "	1,093	1,907

In any engine plant the wages are an appreciable part of the expense of operation of the plant. The following is the actual engine-room force of the *Mariposa* when coal was burned, and also when oil was the fuel; also an estimate of the crew necessary for using a producer-gas plant and an oil-engine plant, with what seems a fair schedule of wages under the four conditions:

	Coal Steam.	Oil Steam.	Producer-gas.	Oil Engine.
Chief engineer.....	1 @ $150—$150	1 @ $150—$150	1 @ $150—$150	1 @ $150—$150
Assistant engineer....	3 @ 100— 300	3 @ 100— 300	3 @ 100— 300	3 @ 100 - 300
Oilers.....	3 @ 60— 180	3 @ 60— 180	3 @ 60— 180	3 @ 70— 210
Firemen.....	12 @ 45— 540	3 @ 45— 135	6 @ 45 - 270	
Coal passers.....	12 @ 40 - 480	....	6 @ 40 - 240	....
Water tenders.....	3 @ 60 - 180	3 @ 60 - 180	....	....
Messenger.....	1 @ 30— 30	1 @ 30— 30	1 @ 30 - 30	1 @ 30— 30
Storekeeper.....	1 @ 60— 60	1 @ 60 - 60	1 @ 60 - 60	1 @ 60— 60
Totals.....	36 $1,920	15 $1,035	21 $1 230	9 $750

It happens in this case that the wages per month go directly with the cost of fuel per trip since the *Mariposa* makes one trip per month. As before stated, no data were available upon the subject of salaries, but figures given are no doubt near enough to actual wages, including cost of feeding the men.

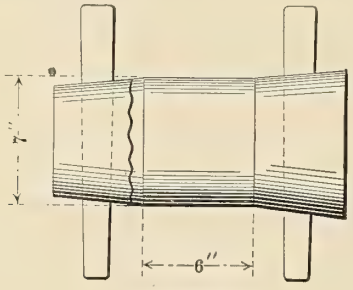
It is probable that the first cost of the oil engine plant will ultimately be considerable less than the cost for the same power steam plant. The oil engine plant will weigh less than the steam plant and there is no reason to expect that the cost per ton of machinery will be greater than for the steam engine.

The total cost per month for operating the *Mariposa* with the four kinds of power, accounting for the fuel used and the wages paid, may be estimated at $4,920 for the first case, $4,035 for the second, $2,575 for the third and $1,833 for the oil engine plant. The saving in dead weight over the steam engine using coal is 261 tons for the second case, 568 for the third and 833 for the oil engine plant. This saving in dead load, which could be utilized for carrying more cargo, should be worth about $3.00 a ton at the very least for the round trip of 7,000 miles. The saving in dead weight, if used up with cargo at this figure, would pay all the expenses of operating the oil engine plant and leave a surplus of $656. The cost of operation of the oil engine plant (with all space taken which was available for cargo) would be $5,576 less than the cost for the steam plant with coal, $3,908 less than the steam engine using oil and $1,530 less than the producer-gas plant.

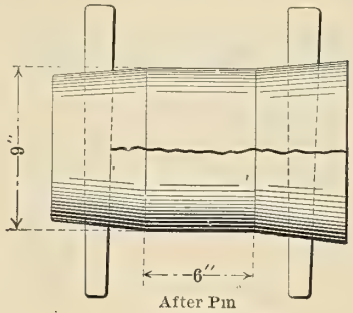
There is no question but what the writer has taken the figure for the price of oil too low, but supposing that the price of the oil is doubled, the increase in the price of fuel for the oil engine will not much more than eat up the surplus of $656 left from the extra cargo carried after taking out the cost of help and fuel. A barrel of oil contains 42 gallons. At twice 1.41 cents a gallon the barrel of oil will be about $1.20.

To the writer it seems that the stir which is now being made in favor of the turbine of one kind or another will be comparatively short lived. For large powers there are great obstacles to be overcome before the steam turbine will be a success. The large power in a vessel naturally calls for a large propeller with a low number of revolutions. The turbine on the other

hand, to be of its least weight per horse power, must be comparatively small diameter and have a high number of revolutions. The two conditions may be partially met, but the result will not show either the propeller or the turbine to its best advantage. There does not seem to be any objection to the design of an engine plant for ocean liners having a power equal to 60,000 steam I. H. P. and using the crude oil Otto for the power. This could probably be done with twin screws, eight cylinders on a shaft, each cylinder generating about 4,000 H. P. This power could be put into a liner about 600 feet long and better time made than is possible with any practical sized steam vessel. Knowing what is being done in the line of developing the crude oil Otto and what the promise is for the future, it seems very evident to the writer that any future important stride in marine engineering must be made, not with the producer-gas plant or the turbine, but with the crude oil engine. JOHN F. WENTWORTH.



Forward Pin



After Pin

Marine Engineering

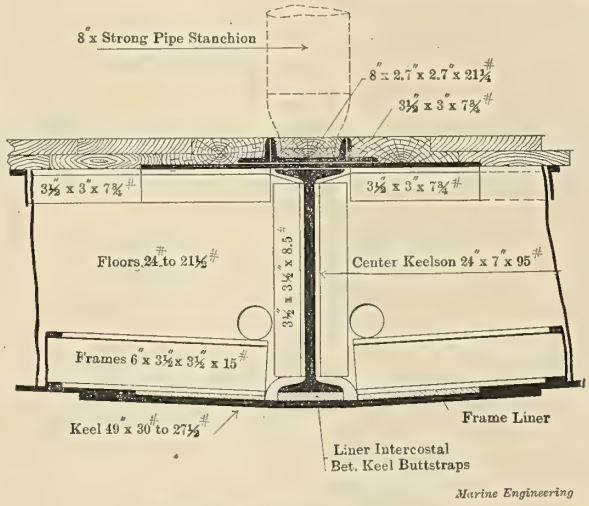
Broken Crank Pin.

The steamer *N*——, a combined freight and passenger steamer of 1,188 gross tons, plying across Lake Michigan, in the month of January, 1904, was sent to the Ferryburg Iron Works for repairs to engines and boilers. She had been in continuous service for eleven months, which included some very heavy work in the ice fields encountered on the route. On taking the crank pin brasses down for examination and adjustment, a very peculiar condition was discovered, both crank pins being broken entirely through, as shown by the drawings.

Her engines are twin steeple compound, cylinders being 20 and 40 inches diameter and 36 inches stroke, steam pressure 92 pounds, revolutions per minute 88. The engines had run no one knew how long in this condition, and gave no indication of the pins being broken, except a slight knock in the forward engine on the bottom center. The forward pin is 6 inches long by 7 inches in diameter; after pin 6 inches long by 9 inches diameter, both keyed into cranks with a double taper. The broken end of the forward pin had to be drilled out as it was impossible to remove it in any other manner. New pins were fitted in and the steamer went in commission in a few weeks and is now covering her route as usual. JAMES D. STEWART.

Novel Center Vertical Keel.

The arrangement of center vertical keel shown in the accompanying engraving has recently been incorporated in the construction of some vessels building in this country, and has much to recommend it on the score of economy and simplicity of construction. The method illustrated was devised by Mr. G. Simpson, recently superintending constructor at the Townsend-Downey yards, and the method by which the scantlings of the various members were calculated was as follows: The scantlings were first taken out in accordance with the requirements of one of the classification societies for a given numeral for the orthodox vertical keel and center keelson construction and the moment of inertia of these calculated about the neutral axis of the ship, as it is the author's contention that such parts of the ship's structure as keelsons, etc., should not be considered as individual members, as is too often done, but as parts of the vessel viewed as one large girder. With this as a basis the novel arrangement shown was figured to give an *equivalent* moment of inertia about the ship's center of gravity. It will readily be seen that it was possible to do this and still save weight owing to the greater section of the I-bar used and its increased distance from the neutral axis. The saving in weight we understand is quite considerable for an equal strength, and of course it will be seen that there is only about one-third of the fitting and riveting entailed in this method of construction. It will also be noticed that great stowage facility is obtainable owing to the complete elimination of the usual obstructive center vertical keelson. The construction shown has been approved by the principal classification bureaus.

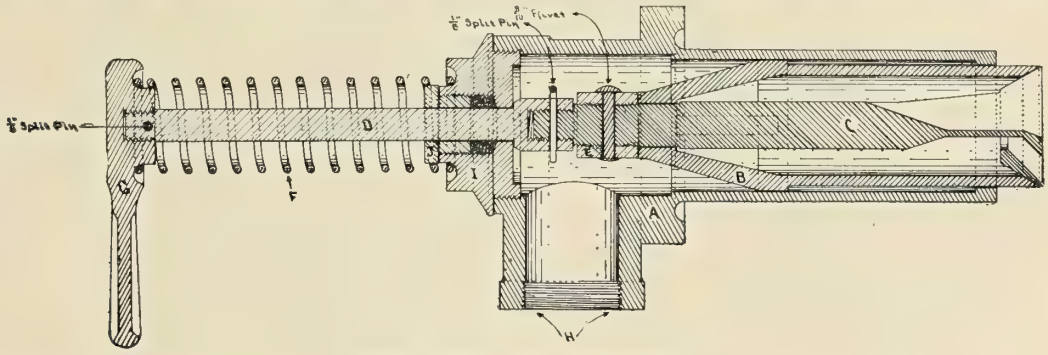

8" x Strong Pipe Stanchion
8" = 2.7" x 2.7" x 21¼#
3½" x 3" x 7¾#
3½" x 3" x 7¾#
3½" x 3" x 7¾#
Floors 24" to 21½#
3½" x 3¼" x 8.5#
Center Keelson 24" x 7" x 95#
Frames 6" x 3½" x 3¼" x 15#
Keel 49" x 30" to 27½#
Frame Liner
Liner Intercostal
Bet. Keel Buttstraps
Marine Engineering

NEW FORM OF CENTER KEELSON.

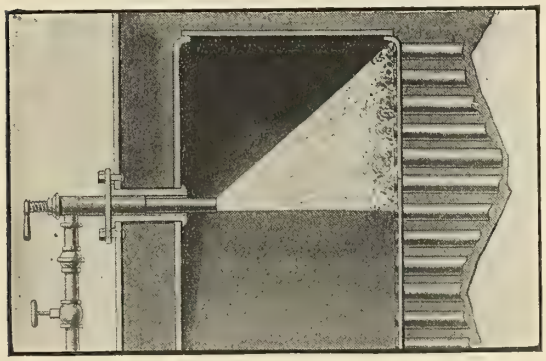
ENGINEERING SPECIALTIES.

New Steam Flue Blower.

The operation of blowing out soot from the tubes of a fire-tube boiler has always been a very tedious one, and at the same time has necessitated a partial shutting down of the boiler. The usual method has been to attach a small blower with hose to a steam pipe and insert the blower in the front ends of the tube. To do this of course the smoke boxes must be opened, checking the draft. The soot has to be blown against the natural draft of the boiler. The result is that the soot is blown back into the boiler, the draft is checked, and the steam pressure will drop. Allowing about a quarter of a minute for blowing each tube, the operation by the old method would take almost an hour, and then, as is well known, the tubes are not perfectly clean at the back. The Diamond steam flue blower, Hodge patent,



SECTION OF NEW STEAM FLUE BLOWER.



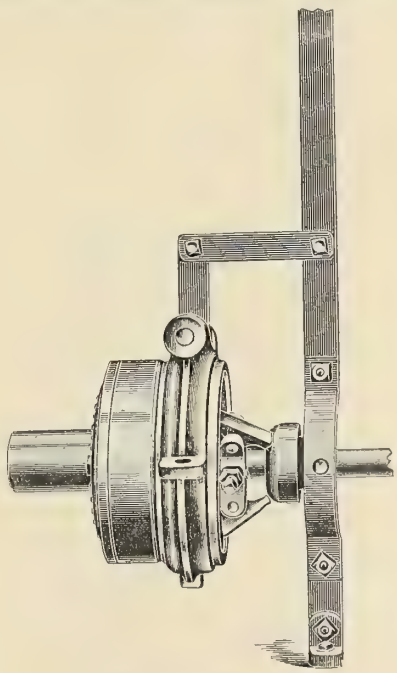
CLEANING BOILER TUBES WITH NEW STEAM BLOWER.

made by the Power Specialty Company, 513 Washington arcade, Detroit, Mich., is a simple device entirely free from the disadvantages of the old method. It is installed in the rear end of the boiler and blows the soot with the natural draft of the boiler to the front and up the funnel. It is stated by those who have used it that to thoroughly clean all the tubes does not take more than five minutes, because it cleans in each operation a cluster of tubes.

Referring to the sectional view: the shell, *A*, is inserted through a tube in the back head of the boiler, into the combustion chamber. Steam is admitted to the nozzle tube, *B*, and nozzle, *C*, through the connection, *H*, and the pressure drives out the nozzle and tube against the compression of spring, *F*. The nozzle is of such a form that the spray of steam is directed at an angle to the axis of the cleaner, and by turning the handle, *G*, the nozzle will revolve causing the steam to spray through a multitude of tubes, within a diameter of 4 feet 6 inches at one time. The flow of steam removes the soot from the tubes and carries it up the funnel.

Ball Reverse Gear.

The Ball improved reverse gear manufactured by the New York Gear Works, 56-58 Greenpoint avenue, Brooklyn, N. Y., is designed to overcome the difficulties of the ordinary reverse gear. There are two disks, one at the front and one at the back of gear, which are



A NEW REVERSING GEAR.

locked together for forward motion by throwing the hand lever forward. When the lever is vertical the disks unlock and the gears run free, therefore the propeller shaft does not revolve. When the lever is thrown aft the gears are brought in mesh and the reverse motion is secured. Spur gears are used made of steel with hardened teeth and run in oil. The device is strong and compact and will stand hard service. It is being used extensively by some of the best marine engine builders.

The Triumph Rod Packing.

The increasing use of high-pressure steam, superheaters, and gas and oil engines has produced a demand for a rod packing capable of continued satisfactory service under high temperatures. James L. Robertson & Sons, of 204 Fulton street, New York, N. Y., feeling the growing urgence of this demand, have for some time been seeking such a packing, and it was in Germany, where both the internal combustion engine and the superheater have reached their highest development and widest application, that their quest has been successful. The packing which they are offering under the above trade name, is one which is being used in large quantities by the Krupps, Borsig, and many other prominent continental builders, and in the German, Austrian, French, Italian, Russian, and Danish navies. It is made up of a series of half rings, of which one is shown in Fig. 1, which are placed in the stuffing box, as shown in Fig. 2, so as to break joints, and with a section of fibrous packing between the gland and the outer section. These half circles are filled with an indestructible lubricant and closed at each end with a metallic diaphragm, so thin as not to resist materially the change of shape of the tube under pressure. The tube is made of an anti-friction alloy, which is varied according to the temperature at which the packing is to be used. Under the pressure of the gland the packing takes an approximately rectangular section, completely filling the stuffing box, and the rod is thus surrounded by a surface of anti-friction metal with automatically formed retaining grooves between the rings, and lubricated with the material which exudes through the perforations in that surface. The packing being made in sizes to fit the rod and box, is as simple of application as the ordinary fibrous packing, and absolutely no change is required in the box or gland. Some 68,000 stuffing boxes are packed with it in Europe. It is claimed to be particularly applicable to compressors, both air and ammonia, in expansion or slip pipe joints, and for acids.

FIG. 1, A SECTION OF THE TRIUMPH ROD PACKING.

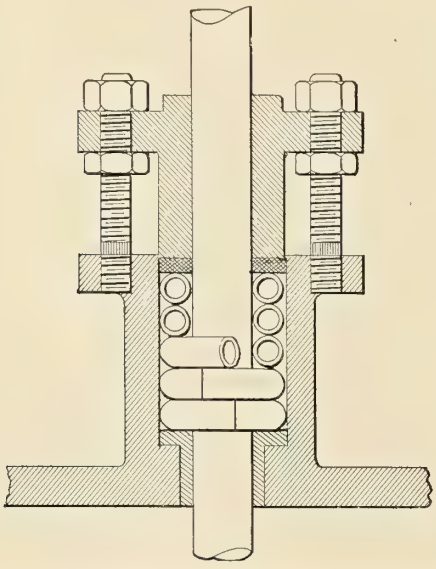


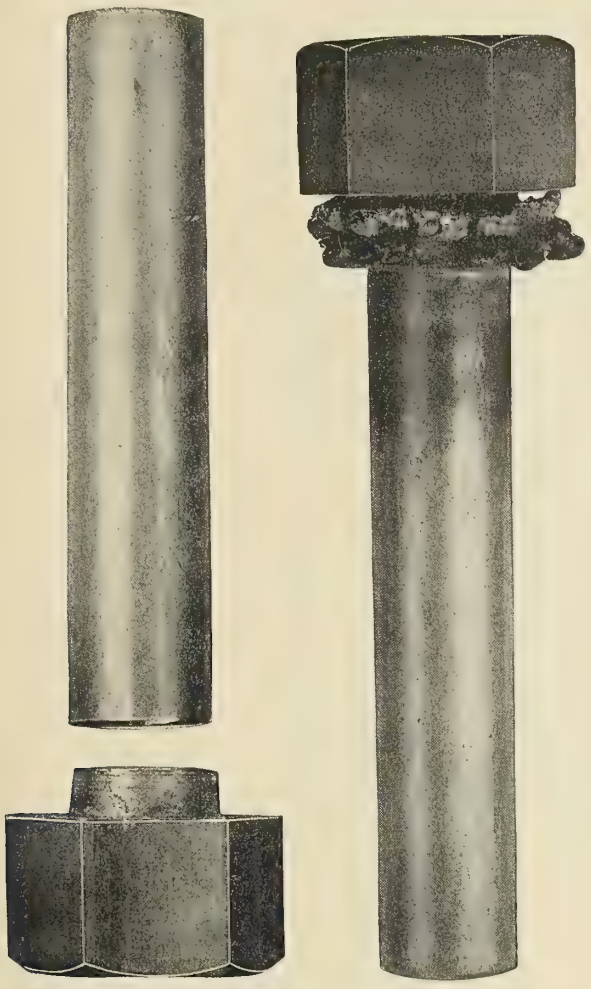
FIG. 2, SHOWING METHOD OF APPLYING NEW ROD PACKING.

Uniform Finished Machine Bolts.

A new process of making screws and bolts has been brought out by the Cleveland Cap Screw Company, 66 Clarkwood avenue, Cleveland, Ohio, which is not only most interesting but permits of an absolutely uniform and exceedingly strong bolt. The heads are made from special die drawn stock—hexagon, square, or round—according to the style of head required. These are cut from a bar on automatic machines which turn a projection or shoulder, to the diameter of the screw to be welded as shown in the cut. The stems are also cut from the same quality round stock which is the diameter of the screw. Thus the threads of the screw are cut directly on the surface of the die drawn stock, which has been proved to be much stronger than the inner portion, as this part of the material is denser and more compact, owing to the pressure of the dies in drawing. This method not only accounts for the greater strength of the screw, but reduces the cost very greatly by re-

ducing the amount of metal required from that of the ordinary screw.

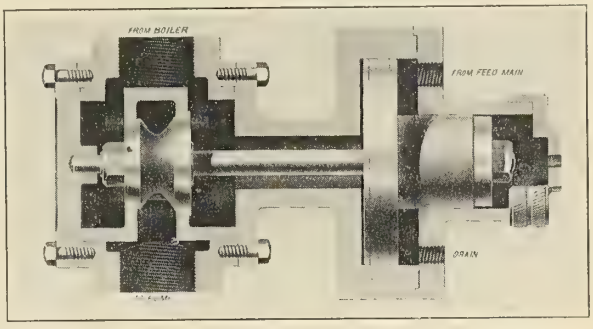
The heads and stems are placed in the welding machine and held firmly by copper vises, which are clamped to gun-metal platens. These platens are moved on steel ways by hydraulic pressure. The sections to be welded are brought together, completing the circuit, and the current is then allowed to pass through these sections until they are brought up to a welding heat, at which time a greater pressure is applied, forcing the two together, expelling any possible slag or deteriorated metal, and forcing up a burr, as shown in the cut.



HEAD AND SCREW BEFORE AND AFTER WELDING.

The next process is the milling down of the burr, which is done by machinery especially constructed for this purpose. At the same time the top of the head is shaved and chamfered, and the under part of the head is faced and the end pointed. It will be seen that this process results in absolute uniformity in the length of the screw, thickness of head, and the alignment of head and body. The blank is then ready for threading, for which special machinery with lead screws are employed for feeding the screws into the dies, which method insures accurate and well-formed threads.

The electric welding process is not confined to making a steel head and steel stem; the company turns out a bolt specially adapted for salt water service where the head is made of tobin bronze or brass and the screw of steel. This meets government requirements where non-corrosive metals are called for. In recent tests carried on, comparing the Cleveland cap screw with twelve other makes, the average tensile stress found was 73 per cent. greater for the Cleveland screw. The bolt is already largely used by engineers who desire a uniform product.



VALVE FOR AUTOMATIC CONTROL OF BOILER FEED PUMP.

Automatic Boiler Feed Pump Controller.

A simple, and, it is claimed, very effective, governor for the boiler feed pump and controlled by the relative pressure of steam and water is herewith illustrated. It is attached directly in the steam line to the pump, and does away with the customary relief valve. With this device, when steam pressure falls, the controller, by reducing the supply of steam to the pump, will shut the pump down, and, conversely, when the steam pressure in the boiler rises, the controller allows additional steam to be delivered to the pump. Thus the action of the controller regulates regardless of the fluctuations of the steam pressure in the boiler and also tends to steady said pressure.

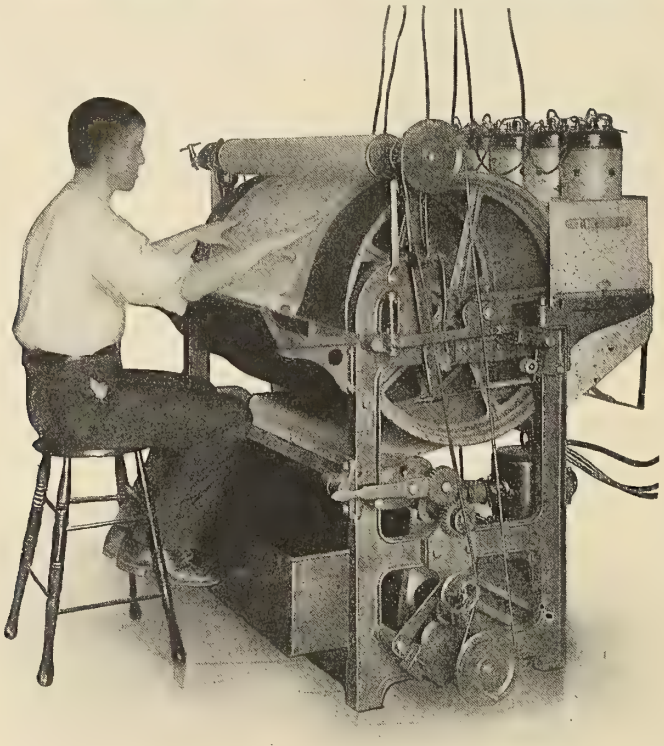
In the sectional view here given the method of balancing the floating piston is illustrated. The steam valve at the left is of the piston type, as steam entering at the top entirely surrounds the valve and valve stem, and the steam pressure is also exerted against the front of right-hand piston. Behind this piston is the water pressure at the water end of the pump. The joints are ground, and metallic packing is used on the water end which may be readily taken up for wear. The steam valve and bushing are of bronze. This valve is made by the Federal Valve Company, 2534 Western avenue, Seattle, Wash.

Blue Printing Machine.

The method of making blue prints by means of a glass cylinder and arc light has quite superseded the original flat plate machine.

The apparatus brought out by the Specialty Print Paper Company, Incorporated, 44 Federal street, Boston, Mass., and termed the Federal blue printing machine, records another conspicuous step in advance for speed and quality of work. The present device illustrated on

this page is of a continuous feeding mechanism. The disadvantages of the glass cylinder, such as the liability of breaking the expensive glass, the loss of time in preparing the apparatus for each separate copy, the limited sizes of prints to be taken at one time, and the labor required in handling the heavy plate glass are entirely absent in the Federal machine. The latter consists of a large drum mounted on roller bearings. Directly above is a small roll upon which is wound a long strip of flexible transparent material called the apron. The ordinary high-grade tracing cloth is generally used for this purpose. This apron lies close upon the drum for about half the circumference, and thence to a winding roll at the bottom. The space between the apron



NEW BLUE PRINTING MACHINE FOR CONTINUOUS OPERATION.

and the top surface of the drum is where the blue print paper and tracings are fed to the machine. The surface of the drum covered by the apron forms the exposing surface of the machine. A reflector supporting a series of lamps is arranged to confine and reflect the rays of electric lights upon this exposing surface. After the tracings and blue prints have been exposed they drop into a box at the bottom. It will thus be seen that as the drum revolves it carries apron, tracing, and blue print paper with it. A perfect contact between tracing and blue print paper is secured by keeping the apron tight. The machine is made in three sizes, with drums 30, 42, and 54 inches in length. The advantages of this machine are that tracings of any length may be printed; that the machine works continuously; and that the amount of exposure, and therefore the printing, can be regulated to a nicety by the operator by increasing or decreasing the speed of the operating motor.

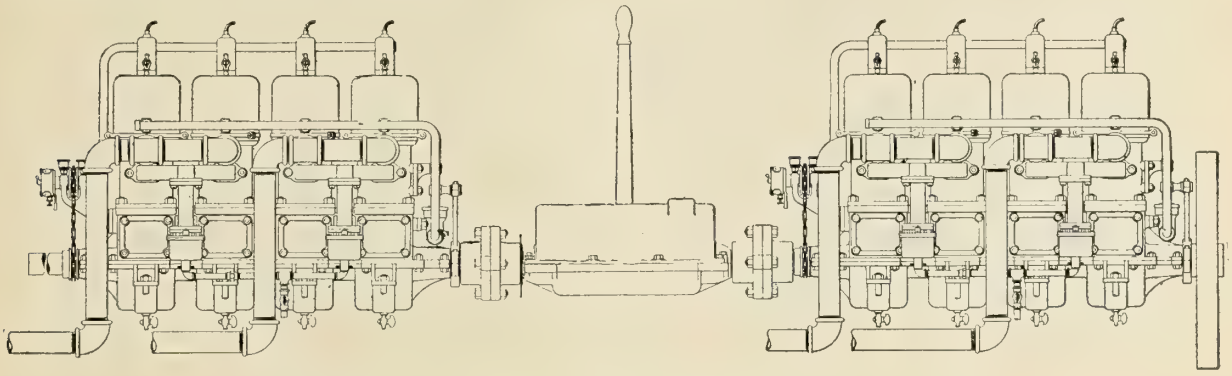
A New Two-Cycle Engine.

The accompanying cut shows a light-weight, high-speed engine, designed for E. H. Godshalk & Co., of Philadelphia, Pa., by E. W. Roberts, Clyde, Ohio.

This engine is of the two-cycle type, 4 1-2 inches bore by 5 inches stroke, and, as is usual with such an engine, is made in two four-cylinder units. What is perhaps an innovation in an eight-cylinder engine is the placing of the reversing gear between two engines, in order to save weight and avoid the necessity of an extra clutch betwen the two engines. As the two-cycle engine will run in either direction by simply changing the lead of the spark the forward engine may be run in one direction and the after engine in the other; or the forward engine may be used to start the after engine in the reverse direction and the forward engine then cut out. By disconnecting the two engines the forward engine may be started by hand and then used to start the after engine by operating the clutch, thus avoiding the use of a starting device.

The principal features of this engine are that the crank cases are of nickel aluminum so treated as to be unaffected by the action of salt water, and the cylinders are of cast steel. The designer claims to have found by experiment in his own laboratory a cast steel that will stand the service. The water jackets are separate from the cylinders and are made of seamless drawn steel shells. The vaporizer is of the compensating type, needing no adjustment for changes in temperature, or in the speed of the engine. The engine has absolutely no valves, as it is of the three-port type, the inlet to the crank cases being opened and closed by the piston. This

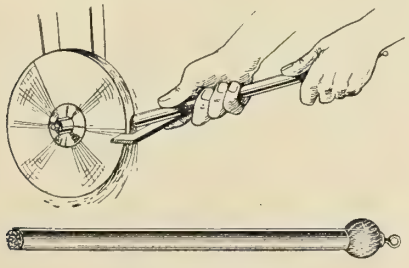
form is found better adapted to high speeds than a check valve. Ignition is of the jump spark type, the timer being driven by a silent chain and the timer shaft supported on a bracket at about one-half the height of the engine. The spark plugs are entirely enclosed in a moisture-proof shield. The engine is 21 inches high from the center of the shaft to the top of the spark-plug shield, and the forward engine is 42 inches long from the center of the coupling to the outside of the fly wheel. The approximate weight of the two engines, exclusive of the reverse gear, is 600 pounds, and at 950 r. p. m., which is the normal speed of the engine, it will develop between 60 and 65 brake horse power.



TWO-CYCLE, 60-HORSE POWER, 8-CYLINDER, HIGH-SPEED MARINE GASOLINE ENGINE.

E. H. Godshalk & Company, manufacturers of Giant engines, propose to build quite a number of different sizes on this same general design. The smallest of these will be 3 7-8 inches bore by 4 inches stroke, developing 4 1-2 horse power per cylinder. A second size will be 4 1-2 by 5 inches, developing 7 1-2 horse power per cylinder. The largest size will be 5 1-8 by 6 inches, developing 11 horse power per cylinder. The normal speed on which these three sizes are rated is 950, 900, and 850 respectively.

No pains have been spared to make this design first class in every particular, with ample strength in all parts and large wearing surfaces, keeping the weight down to the lowest practical limit for good service, making the engine not only of great value as a racing machine, but also for boats where small space and continuous duty are factors.



EMERY WHEEL DRESSER.

The Semi-Diamond Tool.

An emery wheel dresser manufactured by the International Specialty Company, 35 Holden avenue, Detroit, Mich., is designed to take the place of the expensive black diamond. This is the most efficient tool for the purpose, and the makers state that it will do the work of truing and shaping emery wheels in as satisfactory a manner as the diamond dresser. The Semi-Diamond dresser is a steel tube filled with the hardest abrasive that can be obtained, which presents new cutting edges the entire length of the tube and as long as it lasts, which is from three to five years with ordinary use. The dresser is not recommended for water grinders or very hard wheels, although it can be used on such if necessary. Its efficiency is best demonstrated on grades up to medium hard.

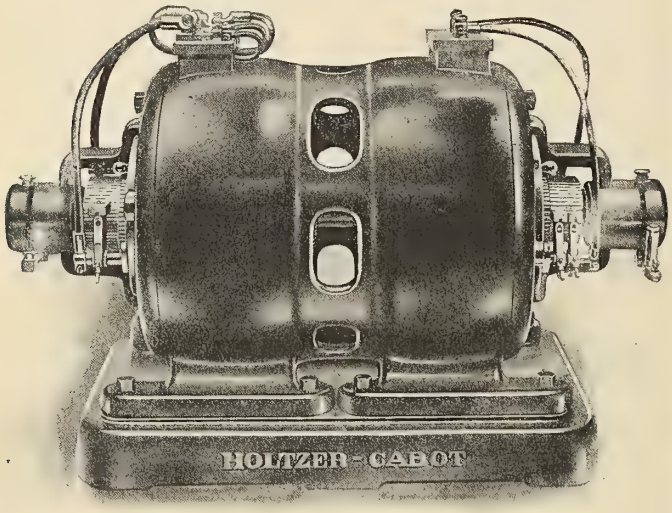
Motor Generators.

With the increase in use of the storage batteries for launches, automobiles, and private lighting plants, has come the demand for a compact and efficient form of charging motor generator. The advantages of the motor generator over the dynamotor for work of this class are well known. In the first place the primary and secondary circuits of the motor generator may be much more effectively insulated from each other than can the windings of the dyanmotor. Furthermore, the secondary voltage of the dynamotor form of machine cannot be regulated except by means of a line rheostat in the secondary circuit or by a speed controller in the motor circuit using resistance in series with the armature, both these methods requiring expensive rheostats and producing a very uneconomical conversion.

The motor generator form of machine is more flexible in its adaptation to the engineering conditions. The voltage of the secondary may be regulated by the field rheostat and if the fields of the generator are separately excited from the motor circuit the voltage of the generator may vary from zero to the full potential of the machine, the current output and stability of voltage being retained throughout the entire range. The machines here illustrated have two bearings, the two intermediate bearings being eliminated. The motor and generator cores are mounted on a common shaft which is continuous. The speeds are low and the shafts quite heavy, so there is no vibration or tendency of the shaft to spring. The output of the machines range from 1-4 to 4 1-4 Kw. The machines may be wound for any direct current circuit, and the secondary wound to give any voltage from 20 to 500.

The manufacturer is also prepared to supply machines of the same range and outputs to the two-bearing construction but of the open type. There is no particular preference in favor of either type, although possibly the open type is a little more accessible.

While these sets are intended primarily for charging batteries they have been found useful in other lines of work, particularly in telegraphic work for operating main and local circuits. The Western Union Telegraph Company is using large numbers of the semi-inclosed type, while the Postal Telegraph Company has in operation quite a number of the open type.



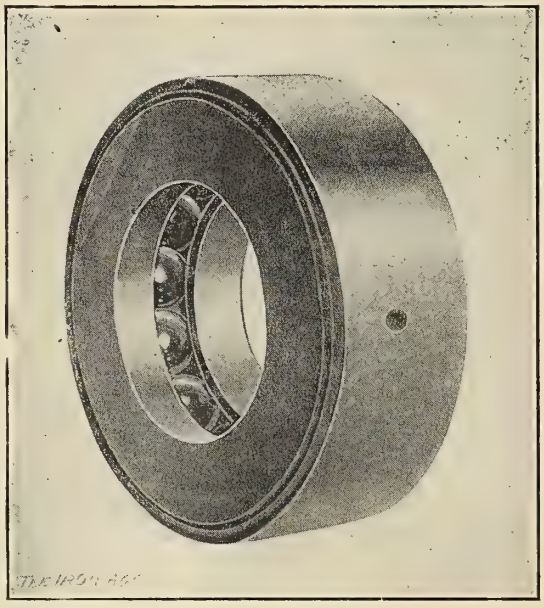
NEW COMPACT TYPE OF MOTOR GENERATOR.

The motor generators are being manufactured by the Holtzer-Cabot Electric Company, Boston, Mass.

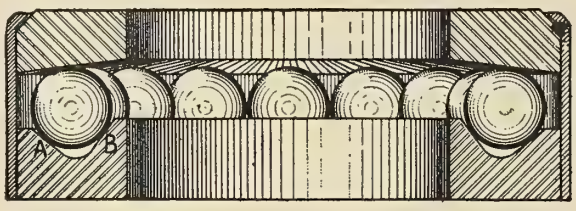
Standard Ball Bearings.

The success or failure of ball thrust bearing depends practically upon the balls which are used therein, and while there are several different manufacturers of ball thrust bearings, the American Ball Company, Providence, R. I., has the unique distinction of being the only manufacturer of ball bearings which manufactures also the balls. These are made by a special treatment from a special high grade of tool steel, into an extremely tough and uniformly hard ball, with great wearing qualities and of high crushing strength. These bearings are manufactured under the patents of M. Reid, in several different forms to suit requirements. A typical bearing is that illustrated in the sectional and perspective views herewith given. The plates are made of tool steel hardened clear through by a special process, and both plates are then ground true to exact dimensions. The sleeve is made of light carbon steel, not hardened, and is driven over the lower breast plating with the upper plating a free running fit and held in place by the flange.

The aim in this design was to construct a bearing in which there should be only rolling contact between the balls and the ball raceways. The two points of contact on the lower plate are in such a position in relation to the axis of the shaft, that the rolling contact circles on the balls are both the same proportion to the contact circles on the same plate. The point of contact on the upper thrust plate is in a plane parallel to a line drawn through the two points of contact on the lower plate; thus it will be seen no sliding can take place between the balls and raceways, and the load on the two points of contact must be equal. The tendency to force the balls outward on account of the difference in the angles of contact on the lower plate is counteracted by the angle on the face of the upper plate forcing them in the opposite direction.



BALL THRUST BEARING.



SECTION OF BALL THRUST BEARING.

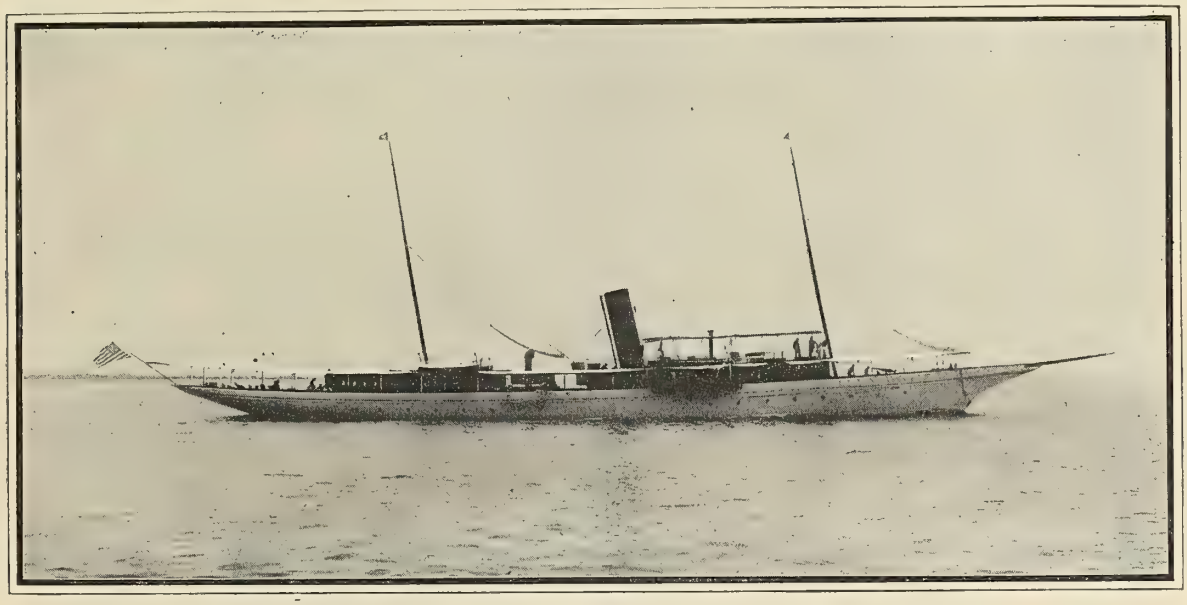
If space permitted mention would also be made of the other styles, and especially No. 1A, which is designed for light work. In regard to the design, selection of material of bearing and of ball, and the finish, the aim of the manufacturer has been to turn out bearings that will reduce to the lowest minimum the amount of friction in a thrust bearing.

Acetylene Safety Storage System.

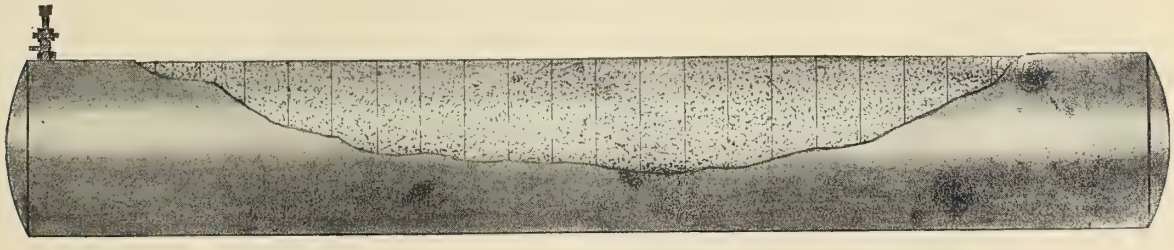
A very satisfactory system for lighting yachts and small boats with acetylene gas is handled by the Commercial Acetylene Company, 80 Broadway, New York, N. Y. Recent developments in storing acetylene gas, consisting chiefly of filling the cylinders with asbestos,

fire brick, or other absorbent material, practically prevent all possibility of an explosion under any circumstances. The system is especially desirable for use on sailing craft, or steam vessels where it is not desirable to run the dynamo throughout the night, or to install an expensive storage battery. The system here described is largely used in Europe, and already many installations have been fitted on land and water in this country.

In the first place, the quality of the light is more nearly like sunlight than any other artificial illuminant. At the same time the quantity used in a gas jet is only 1-10 that of an ordinary burner used with the best city gas, and with 50 per cent. more candle power. The smaller quantity means that the piping may be reduced and also that the danger from asphyxiation or explosion is proportionately reduced. The flame from an acetylene burner is a small, compact one which cannot be blown out, as was clearly demonstrated at the Buffalo exposition and elsewhere, and is thus especially desirable for use on board ship. In this storage system gas called acetone is used in combination with the acetylene, by which it is claimed that the carrying capacity of any tank of a given size under a given pressure is greatly increased. It is estimated that a yacht such as the *Oneida,* which is fitted with twenty-seven acetylene burners, requires but 450 cubic feet per month; the tanks installed are 16 inches diameter and 54 inches long and hold 900 cubic feet of the gas. This one tank will last two months. Several other yachts, including the *Haouli,* here illustrated, make use of this system of lighting, which, it is claimed, gives perfect satisfaction.



STEAM YACHT HAUOLI, LIGHTED BY ACETYLENE GAS ON THE SAFETY STORAGE SYSTEM.



SECTION OF SAFETY STORAGE TANK FOR ACETYLENE.

Marine-Engine Governor.

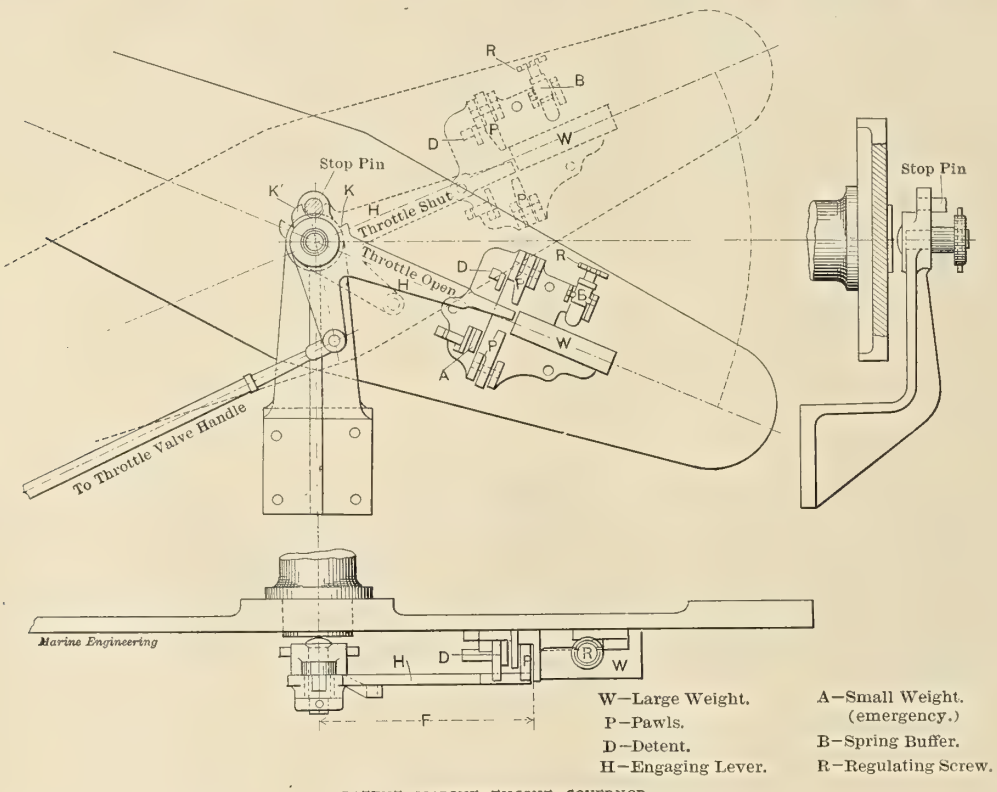
The Aspinall marine-engine governor is a simple and inexpensive device attached to marine engines which not only will prevent racing in heavy weather but will shut off the steam entirely in case of a breakdown. It works automatically, controlling the revolutions of the engine within 5 per cent. of any predetermined speed, thus preventing the sudden excessive strains which so often cause fracture of shafting or more serious accidents. The governor, which weighs from 17 to 50 pounds, is fixed on the pump levers, or other reciprocating part, and being exceedingly sensitive, certain, and powerful in its action, the slightest acceleration of speed shuts off the supply of steam by means of the throttle or other valve. The governor consists of a hinged weight, *W,* operating two pawls, *P, P,* carried on a frame which is bolted to air-pump lever, or other reciprocating part.

When the revolutions of engines are increased by about 5 per cent. above the normal speed, the weight, *W,* is left behind, and reverses the position of the pawls, causing the bottom one to engage with the lever, *H,*

lifting it throughout the whole upward stroke, and thus shutting off steam by closing the throttle valve. On the return stroke the detent, *D*, is lifted, liberating the weight, *W*, and, if the revolutions have moderated, the position of the two pawls is again altered, the top pawl now engaging with lever, *H*, depressing it, and thus re-opening the throttle valve.

The emergency gear only comes into operation in case of a very excessive race, such as losing a propeller or a broken shaft, in which case the small weight, *A*, is left behind and locks the weight, *W*, in the "shut-off" position, thus effectually preventing the re-opening of throttle valve. To unlock the emergency gear, press the large weight, *W*, upwards from the under side, when the small weight, *A*, will fall out of gear.

The governor has been successfully fitted to over a thousand modern steamers, including all of the well-known transatlantic fleet. It is manufactured by the Aspinall's Patent Governor Company, 7 Strand street, Liverpool, Eng.



PATENT MARINE ENGINE GOVERNOR.

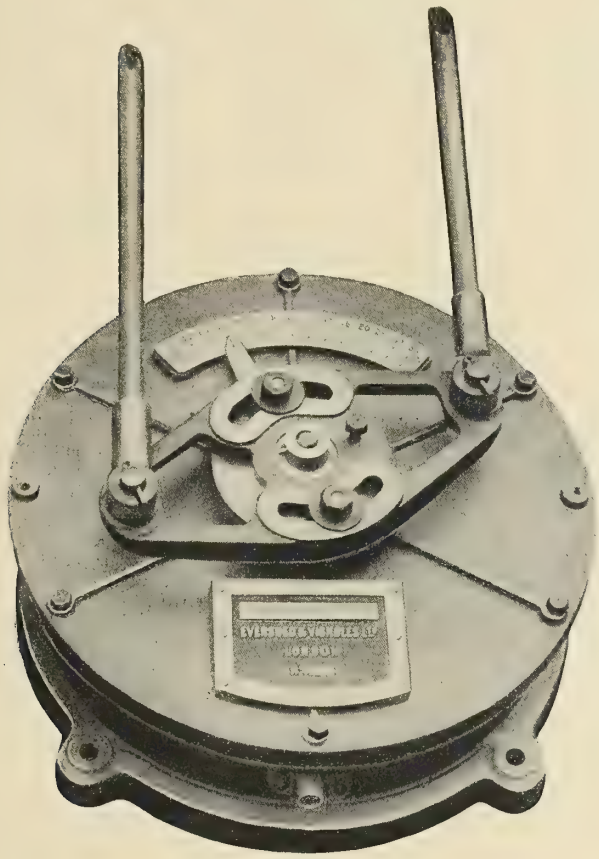
Transmission of Intelligence on Shipboard.

For some years the Evershed-Vignoles Company of London has been occupied in the development of a most interesting line of special telegraph apparatus for the transmission of information on shipboard. Certain types of this apparatus are intended to indicate the position of the helm and others to transmit from a distance orders to the engine room. The system consists essentially of an indicator involving the principle of the measurement of electrical resistance. In this indicator the position of the index is determined by the relation of the currents in two coils placed at right angles to each other. The transmitter consists essentially of a series of resistances with contacts on which one can move a handle or governing arm. If one of these coils is connected to one of the extremities of this series of resistances and the other coil to the other extremity, if, furthermore, the current enters through the handle and leaves at the joint where the coils are connected to each other, the position of the index of the instrument will depend on the position of the handle.

In the helm indicator the transmitter contains the resistances and a handle. This last is put into operation by two parallel bars which connect it with the helm. The position of the coupler determines automatically, in the manner already indicated, the position of the needle of the indicator. Several indicators may be connected in circuit with one transmitter. The officer of the watch can then readily keep himself acquainted with the position of the helm, whether on the bridge, or poop, or other part of the ship. There is never need for more than three lines of wire connection, usually made in cable form with three parts in different colors. All parts of the apparatus are water tight.

The second application has for its purpose the control of the ship, either from the poop, or any other point at pleasure, without calling into operation either mechanical agencies of any kind, or water pipes, as in the case in which one might wish to employ a telemotor. The direction telegraph provides for the control of the ship from the poop, while the actual control is made effective under the deck. As all of the communications are carried on by means of a cable of four strands, it is evident that the risks of derangement or damage are much less than with mechanical connections or with a

telemotor. Each position from which it may be desired to control the ship is provided with a transmitter actuated by hand by the officer of the watch. This signal is then transmitted to an indicator. When the helmsman has executed the order thus transmitted, the automatic helm indicator shows to the officer the angle taken by the helm. He can thus be immediately assured that his order has been received and executed. The transmitter is provided with a disk of unpolished glass carrying figures, and is lighted in the interior of the instrument. The order is received on an indicator exactly similar to that which indicates the position of the helm.



PATENT HELM INDICATOR.

The third application of this system is a form of telegraph intended to transmit the orders of the officer of the watch to the engine room. It may be employed for example to indicate the desired number of revolutions of the engine. By means of an ingenious device, two indicators show all the numbers from 20 to 129. The receiving disk is provided with two columns of figures. That on the left indicates tens and that on the right units. A black line rises and falls before each of these scales. Its movement is obtained very simply by a relay. The system permits the transmission of more than 100 signals on a single disk, at the same time preserving great precision of transmission. Such a result could clearly not be obtained by an index of the ordinary kind.

QUERIES AND ANSWERS.

Q. 262.—Will you please be so kind as to inform me through Queries and Answer column, if there is a jump spark so-called, on gasoline engines, that will not short circuit, or, in other words, circuit proof, and where I may be able to obtain same. As you no doubt know, this can be done with the make-and-break system, but with the jump spark if any moisture whatever gets on the wire or plug it will short circuit and the spark will not go where it should. Also, if a magneto can be used on a jump spark the same as on a break-and-make? J. L. T.

A.—By using rubber covered wire and taping all connections with a good insulating compound, a jump spark will be as reliable as the make-and-break sparkers.

There is a device made in England by which a spark will pass between the proper parts of a plug when same is immersed in water. An expert recently asked for quotations on this and received a price list on ordinary spark coils with the information that the device was too costly. As this scheme increased the voltage of the spark circuit it may be there are unknown difficulties to be met, but as he expects in the near future to try this out and give the results in an article in MARINE ENGINEERING, it will be well to look out for the article. A magneto or dynamo can be used with a jump spark coil successfully, but the coil must be wound for this purpose as one wound and insulated for battery current will be too apt to break down with the other sources of current.

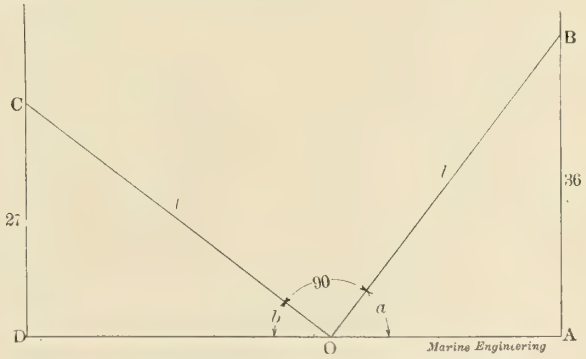
Q. 263.—In examination for admittance to one of the engineering schools near here the following example was given out:

A ladder whose foot rests in a fixed position just reaches a window 36 feet from the ground on one side of the street, or when turned about its foot it just reaches over on the other side 27 feet from the ground. The two positions of the ladder are at right angles to each other. Find the length of the ladder and the width of the street.

I am a marine engineer, and, with other engineers, we have debated as to the correct solution of this problem. Kindly inform us through your valuable columns the correct method of working this kind of examples. This was referred to you at the request of several readers of your magazine, including myself.

J. W. S.

A.—There are several different solutions to this problem, but the one which appears to us the simplest is as follows:



We assume that you are acquainted with some of the fundamental properties of an angle, such as the sin and cosin. Referring to the figure, the angle about O, the base of the ladder, from A to D is 180 degrees. Now by your statement angle BOC is 90 degrees; therefore $a + b = 90°$, or $a = 90° - b$. That is to say, b and a are complimentary to each other.

Therefore sin a = cos b.

Also by your statement the lines *AB* and *CD* are perpendicular to *AD*. Therefore the triangles *OAB* and *ODC* are right angle triangles.

Therefore sin $a = 36 \div l$, but as sin a = cosin b, cos $b = 36 \div l$.

Now l, the hypothenuse, is a fixed quantity.

Therefore $OD = 36$. Similarly we find that $OA = 27$.

In a right angle triangle the sum of the squares of the two legs equals the square of the hypothenuse, $OA^2 + AB^2 = l^2$, or $27^2 + 36^2 = l^2$.

Therefore $l = \sqrt{(27 \times 27) + (36 \times 36)} = \sqrt{2{,}025} = 45$.

Q. 266.—I have two questions I would like to have answered. Why is it that a twin-screw vessel having the screws turning outboard will give more speed to that boat than one whose propellers turn inboard with the same degree of pitch, same diameter and same number of revolutions per minute? I would like to know how the degree of pitch of a screw propeller is found. Hoping these question will be answered. H. F. H.

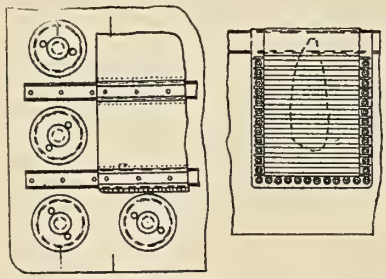
A.—The general practice now appears to be in favor of the outboard turning screw. The British navy has adopted this method. The reason for the increased speed sometimes observed has never yet been satisfactorily explained, and is not subject to mathematical treatment; one theory advanced is that as the blades always carry down with them more or less air, if they turn outboard the quantity of air is less, as it will be forced out by the solid water surrounding, while if they turn inboard the proximity of the side of the ship, with its attendant eddies and broken water, hinders the free run of water to the blade. Thus, with the former arrangement the wheel is working in more solid water.

Your second question we presume is for determining the pitch from the propeller itself, and not from the design. Lay the propeller with the after face down. Establish the center line of shaft by means of a thin piece of wood wedged across the bore. From this center measure on a straight edge laid across the face of the hub and over a blade, some even dimension in feet to about the center of the blade; lay this distance off at two points on the blade, one near the entering edge the other near the following edge and at a conveniently even number of inches apart. Measure down vertically from the straight edge leveled across the face of the hub to these two points. Let us assume that we took these two points on the blade at a distance of 3 feet from the center line and that the propeller is 12 feet in diameter; that the distance between the two points on the blade is 16 inches; and that the vertical distances down are 2.3 and 12.9 inches respectively: then we proceed as follows:

The horizontal distance between the two points on the blade is found by rules of the right angle triangle, the hypothenuse is 16 inches, one leg is 12.9 — 2.3 = 10.6 inches, therefore the horizontal distance, the other leg, is $\sqrt{16^2 - 10.6^2} = 12$ inches. Now at a radius of 3 feet the circumference is $3.1416 \times 3 \times 2 = 18.89$ feet nearly, and on this radius the pitch for a distance of 12 inches we have found to be 10.6 inches. As 12 inches is $\frac{1}{18.89}$ of the whole circumference, the pitch for the entire wheel must be $\frac{10.6'' \times 18.89}{12} = 16.7$ feet, or 16 feet 8 inches. It is well to find the pitch of the surface near the hub and also near the tip, as on some wheels they are different.

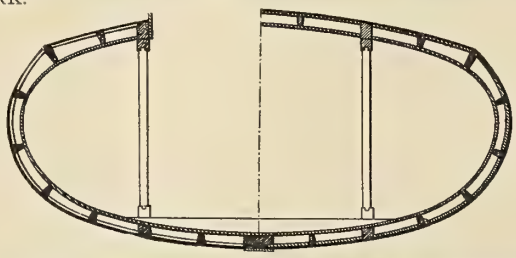
SELECTED MARINE PATENTS.

770,078. MAGNETIC CURTAIN FOR COVERING LEAKS IN SHIPS. LUDWIG KRUGER, SONDERBURG, GERMANY.



Claim.—2. A flexible curtain for covering holes in the side of a ship, composed of a sheet of rubber reinforced by a plurality of iron bars secured upon said cloth and covered by a canvas, the edges of said rubber cloth being provided with pieces of magnetized steel the outer piece being concave and the inner piece being convex, snugly fitting in the cavity of the outer piece, both being united by screws, rivets, or the like, and clamping between them the rubber cloth. Two claims.

770,838. VESSEL-HULL. HENRY N. WHITTELSEY, NEW YORK.



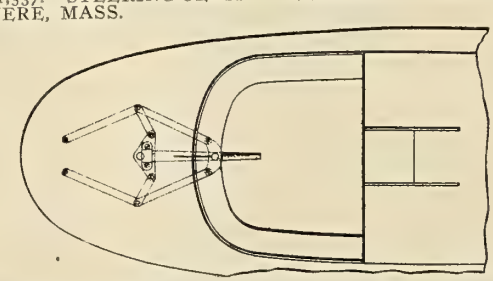
Claim.—1. In a vessel-hull, the combination with longitudinal members, outside frames and inner frames, said outside frames being substantially flush with the outer edges of the longitudinal members, of planking of substantially the same width as the spacing of the longitudinal members and fastened along its abutting edges to such longitudinal members.

2. In a vessel-hull, the combination of the keel outside frames secured thereto on each side thereof, continuous inner frames passing over the keel, longitudinal members between the frames, and planking the same width as the spacing of the longitudinal members fastened along its abutting edges to said longitudinal members.

3. In a vessel-hull, the combination of longitudinal members, continuous inner frames curving from the sides to the deck, outside frames and deck-carlines meeting at an angle at the gunwale, and a longitudinal member supporting the joints and of greater depth than those immediately above and below it.

4. In a vessel-hull, the combination with longitudinal members, outside frames and inner frames, said outside frames being notched into the longitudinal members, of planking fastened along its abutting edges to such longitudinal members. Four claims.

771,537. STEERING-GEAR. PILLSBURY C. DOLLIVER, REVERE, MASS.



Claim.—1. In a steering-gear, a rudder-post, two oppositely-disposed toggle-levers connected thereto, a tiller pivoted to move horizontally, and connections between said tiller and each toggle-lever, whereby the motion of the tiller is communicated to the rudder-post through the toggle-levers.

2. In a steering-gear, a rudder-post, two oppositely-disposed toggle-levers situated in the same plane and extending in the same general direction, a tiller pivoted to move horizontally, and connections between said tiller and each toggle-lever. Fourteen claims.

772,309. AUXILIARY STEERING-GEAR FOR SHIPS. EARL C. AKERS, PORT HURON, MICH.

Claim.—1. A ship's steering-gear comprising a main steering mechanism operatively connected with the rudder, a spare steering-gear normally disconnected from the rudder, and means operating to automatically release said main steering mechanism from the rudder when said spare gear is operatively connected with the rudder. Twenty-two claims.